RELIANCE ELECTRIC

Distributed Power System SA3100 AC Power Modules

Instruction Manual S-3058-1

Rockwell Automation

Throughout this manual, the following notes are used to alert you to safety considerations:

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Important: Identifies information that is critical for successful application and understanding of the product.

ATTENTION: Only qualified personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: The user must provide an external, hardwired stop circuit outside of the drive circuitry. This circuit must disable the system in case of improper operation. Uncontrolled machine operation may result if this procedure is not followed. Failure to observe this precaution could result in bodily injury.

ATTENTION: The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

ATTENTION: The Power Module contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing, or repairing this equipment. If you are not familiar with static control procedures, refer to Rockwell publication 8000-4.5.2, Guarding Against Electrostatic Damage, or to any other applicable ESD protection handbook. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

ATTENTION: When user-installed control wiring with an insulation rating of less than 600V is used, this wiring must be routed inside the Power Module enclosure in such a way that it is separated from any other wiring and uninsulated live parts.

The information in this users manual is subject to change without notice.

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CHAPTER 1

Introduction

The SA3100 AC Power Modules are variable-voltage, variable-frequency inverters for use within the AutoMax™ Distributed Power System (DPS) environment. These Power Modules drive 3-phase AC motors at variable speeds using pulse-width-modulation (PWM) technology. Operation is programmed and controlled using the AutoMax Programming Executive software (Version 3.5 or higher).

SA3100 Power Modules are available in configurations rated from 1 to 800 HP with input voltages from 230 to 575 VAC or from 310 to 775 VDC (common bus). They are supplied in an enclosure for stand-alone operation or open-chassis for mounting within a suitable user-supplied enclosure. Several types of Encoder/Resolver feedback devices are available. An interface for Flex I/O is also provided.

Figure 1.1 and table 1.1 describe the SA3100 catalog numbering scheme and Power Module rating codes for DPS SA3100 drives.

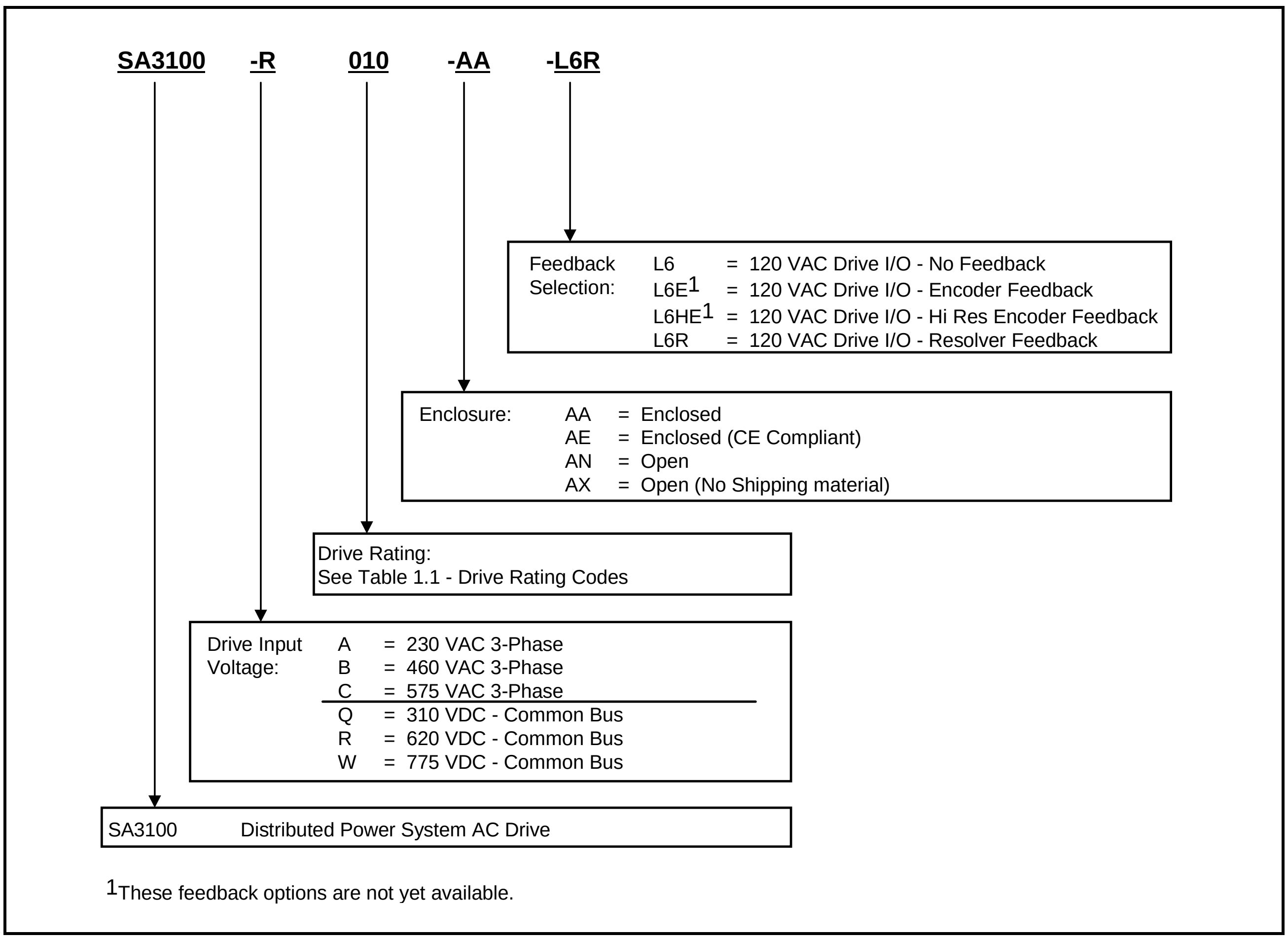


Figure 1.1 – SA3100 Catalog Numbering Scheme

Table 1.1 – Power Module Rating Codes

A / Q 230VAC / 310VDC Code = HP	B / R 460VAC / 620VDC Code = HP	C / W 575VAC / 775VDC Code = HP	Frame
001 = 1.0	001 = 1.0	001 = 1.0	B
003 = 3.0	003 = 3.0	003 = 3.0	
007 = 7.5	007 = 7.5	007 = 7.5	
010 = 10	010 = 10	010 = 10	
015 = 15	015 = 15	015 = 15	
	020 = 20	020 = 20	
	025 = 25		
	030 = 30		
020 = 20	040 = 40	025 = 25	C
025 = 25	050 = 50	030 = 30	
030 = 30		040 = 40	
		050 = 50	
		060 = 60	
040 = 40	060 = 60	075 = 75	D
050 = 50	075 = 75	100 = 100	
060 = 60	100 = 100	125 = 125	
	125 = 125		
075 = 75	150 = 150	150 = 150	E
100 = 100	200 = 200	200 = 200	
125 = 125	250 = 250	250 = 250	
		300 = 300	
	300 = 300	350 = 350	F
	350 = 350	400 = 400	
	400 = 400		
	450 = 450	450 = 450	G
	500 = 500	500 = 500	
	600 = 600	600 = 600	
		650 = 650	
	800 = 800[1]	800 = 800[2]	H

1. 620 VDC common bus only
2. 775 VDC common bus only

1.1 Standard Features

Distributed Power System SA3100 Power Modules have the following features:

- Input power supplied from a three-phase AC line or a common DC bus
- PWM inverter to convert DC power to variable frequency AC power for 3-phase induction motors
- IGBT power semiconductors
- Carrier switching frequencies from 1 to 12 kHz, 1 to 6 kHz, or 1 to 4 kHz, depending upon model (See Appendix A).
- Short circuit protected outputs
- Electronic motor overload protection
- Fiber-optic communication with the Distributed Power System host, the Universal Drive Controller (UDC) module
- MOV surge protection
- On-line diagnostics
- UL Listed/CUL Certified

1.2 Related Publications

This manual describes the SA3100 Power Module hardware. Installation guidelines are also provided. Additional information about using the SA3100 drive is found in the wiring diagrams, prints, and other documentation shipped with each drive system. Always consult the prints shipped with your drive system for specific information about installing, operating, and maintaining your drive.

The other instruction manuals in binder S-3053 describe the SA3100 PMI Regulator, software, and communications. Table 1.1 lists the document part numbers.

Table 1.2 – SA3100 Documentation (Binder S-3053)

Document	Document Part Number
SA3100 Information Guide	S-3054
Drive System Overview	S-3005
Universal Drive Controller Module	S-3007
Fiber Optic Cabling	S-3009
SA3100 Drive Configuration & Programming	S-3056
SA3100 PMI Regulator	S-3057
SA3100 Power Modules	S-3058
SA3100 Diagnostics, Troubleshooting, & Start-Up Guidelines	S-3059

Power Module replacement parts and service procedures are contained in the instruction manuals listed in table 1.3.

Table 1.3 – SA3100 Power Structure Service Manual Cross Reference

AC Input Voltage	DC Bus Input Voltage	Nominal HP	Frame Size	Use Service Manual 1336 Force-
200 VAC - 240 VAC [A]	310 VDC [Q]	1	B	6.11
		3		
		7.5		
		10		
		15		
		20	C	6.12
		25		
		30		
		40	D	6.13
		50		
		60		
		75	E	6.14
		100		
		125		

Table 1.3 – SA3100 Power Structure Service Manual Cross Reference

AC Input Voltage	DC Bus Input Voltage	Nominal HP	Frame Size	Use Service Manual 1336 Force-
380 VAC - 480 VAC [B]	513 VDC - 620 VDC [R]	1	B	6.11
		3		
		7.5		
		10		
		15		
		20		
		25		
		30		
		40	C	6.12
		50		
		60	D	6.13
		75		
		100		
		125		
		150	E	6.14
		200		
		250		
		300	F	6.14
		350		
		400		
		450	G	6.15
		500		
		600		
		800	H	6.15

Table 1.3 – SA3100 Power Structure Service Manual Cross Reference

AC Input Voltage	DC Bus Input Voltage	Nominal HP	Frame Size	Use Service Manual 1336 Force-
500 VAC - 600 VAC [C]	675 VDC - 800 VDC [W]	1	B	6.11
		3		
		7.5		
		10		
		15		
		20		
		25	C	6.12
		30		
		40		
		50		
		60		
		75	D	6.13
		100		
		125		
		150	E	6.14
		200		
		250		
		300		
		350	F	6.16
		400		
		450	G	6.15
		500		
		600		
		650		
		800	H	6.15

1.3 Related Hardware and Software

The following related hardware and software is purchased separately:

- P/N 613614-xxS Fiber-Optic Cable (Cable length xx is specified in meters.)
- B/M O-57652 Universal Drive Controller (UDC) Module
- M/N 57C657 AutoMax DPS Option Version 2.2 or later
- AutoMax Programming Executive Version 3.5 or later

CHAPTER 2

Power Module Description

This chapter provides information on the Power Module's mechanical and electrical characteristics. The individual components of the Power Module differ according to the type of input power (AC or DC) and the Power Module's horsepower rating and frame size. Appendix B provides a schematic diagram of each design. The following sections provide a general description of the Power Module's main components and their functions.

2.1 Mechanical Description

AC input Power Modules have the following main components:

Three-phase AC input

- Three-phase incoming AC power terminals (R-L1, S-L2, T-L3) are provided on terminal board TB1 for connection to the 230, 460, or 575 VAC line. Two current transformers sense AC line current and provide feedback to the PMI Regulator.

MOV Surge Protector

- SA3100 Power Modules are equipped with MOVs (Metal Oxide Varistors) that provide voltage surge protection, phase-to-phase and phase-to-ground protection in conformance with IEEE 587.

Three-phase Rectifier

- The function of the rectifier is to convert the three-phase AC line voltage into an unregulated DC voltage for use by the inverter section. Depending upon the power rating, a six-pulse diode rectifier or a six-pulse SCR rectifier may be used.

All SA3100 Power Modules have the following main components:

Ground Fault Detection Circuit

- Hardware is provided to detect excessive ground current and generate a fault. For models A001/Q001 and A003/Q003 the hardware trip point is 20A @ 10V. For all other models it is 100A @ 10V.

Capacitor Bank Assembly

- The capacitor bank's electrolytic capacitors store power for the IGBTs (insulated gate bipolar transistors) in the power bridge to use to drive the motor.

Pre-charge Assembly

- The pre-charge assembly for common bus and diode rectified stand-alone Power Modules consists of a pre-charge resistor or resistors, SCR/diode, and a printed circuit board assembly. The SCR/diode is used to bypass the pre-charge resistor(s) after bus voltage reaches a programmable threshold value.

DC-to-DC Converters

- The DC-to-DC converters provide 24 VDC for use by the gate drivers as well as the +5, +15, and -15 VDC necessary for the PMI Regulator and other circuits.

Gate Driver Board

- The gate driver board receives gate firing signals from the AC power control circuitry on the PMI Regulator and converts these signals into the appropriate voltage and current levels to turn the IGBTs in the inverter power bridge on and off. Feedback indicating the status of the gate drivers and IGBTs is then sent back to the PMI Regulator.

Inverter Power Bridge

- The function of the Inverter power bridge is to convert the Power Module’s internal DC bus voltage to three-phase AC power with controllable amplitude and frequency. The inverter power bridge contains six state-of-the-art semiconductor IGBTs. These are switched on and off by the gate drivers to provide modulated phase voltages (U, V, W) to the motor.

Snubber

- The resistors, diodes, and capacitors of the snubber circuitry control the voltage overshoot and undershoot produced when the IGBTs are switched on and off.

PMI Regulator

- The PMI Regulator consists of a large main motherboard and a Resolver & Drive I/O board mounted above the motherboard. The motherboard contains the PMI Regulator’s processor, AC power control circuitry, and a Flex I/O interface. Fiber-optic and meter ports are provided along the lower edge of the motherboard. An LED status indicator board displays drive status and errors. The PMI Regulator is described in instruction manual S-3057.

Resolver & Drive I/O Board

- The Resolver & Drive I/O board provides position feedback used for speed regulation. This board also provides an analog input connection that can be used for an analog tachometer or other user input device and digital I/O connections for standard drive-related signals, such as motor thermal overload. See instruction manual S-3057 for further information.

Fiber-Optics Communications Ports

- Fiber-optic cabling is used for communication between the Universal Drive Controller (UDC) module in the AutoMax rack and the PMI Regulator because it is immune to electromagnetic interference (EMI) and eliminates ground loops. For more information on fiber-optic cabling refer to the Distributed Power System Fiber-optic cabling instruction manual (S-3009).

2.2 Electrical Description

On AC input Power Modules, three-phase input power is applied through terminals R-L1, S-L2, and T-L3. A current transformer is used to sense ground faults. The AC input voltage is converted into DC voltage by a three-phase full-wave rectifier bridge. See Appendix B.

On small (B frame) common bus Power Modules, the negative DC bus is applied to the R-L1 input (TB1-5). The positive DC bus is applied to the T-L3 input (TB1-7). See figure 3.7 and Appendix C.

On C frame and larger common bus Power Modules, the DC bus is connected directly to the DC+ and DC– terminals on terminal block TB1. See figures 3.8 to 3.10 and Appendix C.

With power applied, the internal DC bus begins charging through the pre-charge resistors. Once the DC bus capacitors are fully charged and all pre-charge criteria are met, the pre-charge SCR is gated, bypassing the pre-charge resistors. Operation of the various pre-charge circuits is described in Appendix E.

The DC bus voltage is filtered by the electrolytic capacitors and is fused by fast-blow fuses. Discharge resistors on the DC bus capacitors will discharge the capacitors down to 50 VDC within 1 minute after power is removed from the input terminals.

The rectified, filtered DC voltage is fed to the inverter which produces the variable-voltage, variable-frequency output to the motor (terminals U, V, W). The inverter IGBTs are switched by the gate driver circuit under the command of the AC power control section of the PMI Regulator. Three Hall-effect devices (two on the output and one on the DC bus) provide current feedback to the PMI Regulator. AC output power inductors limit the magnitude of di/dt on the U, V, and W terminals.

Refer to Appendices B and C for schematic diagrams of the SA3100 Power Module.

CHAPTER 3

Installation Guidelines

ATTENTION: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

This chapter describes the guidelines and wiring recommendations to be followed when installing SA3100 Power Modules. The guidelines described cover Power Module frame sizes B through H. This chapter provides general guidelines only. System wiring is to be done according to the supplied wiring diagrams (W/Es), which are application-specific.

3.1 Planning the Installation

An incorrectly applied or installed Power Module can result in component damage or reduction in product life. Observe the following guidelines when planning your installation:

- Locate the Power Module in a clean, cool, and dry area. Follow the recommendations given in IEC 68 concerning environmental operating conditions.
- Allow adequate clearance for air ventilation.
- Ensure that surrounding components do not block service access to the Power Module.
- Do not install above 1000 meters (3300 feet) without derating. See Appendix A.
- The relative humidity around the Power Module must be kept at 5 to 95% (non-condensing).
- For open chassis drives, ambient operating temperature must remain between 0 and 50° C. For enclosed drives temperature must remain between 0 and 40° C.
- Refer to Appendix D for maximum motor cable lead lengths.

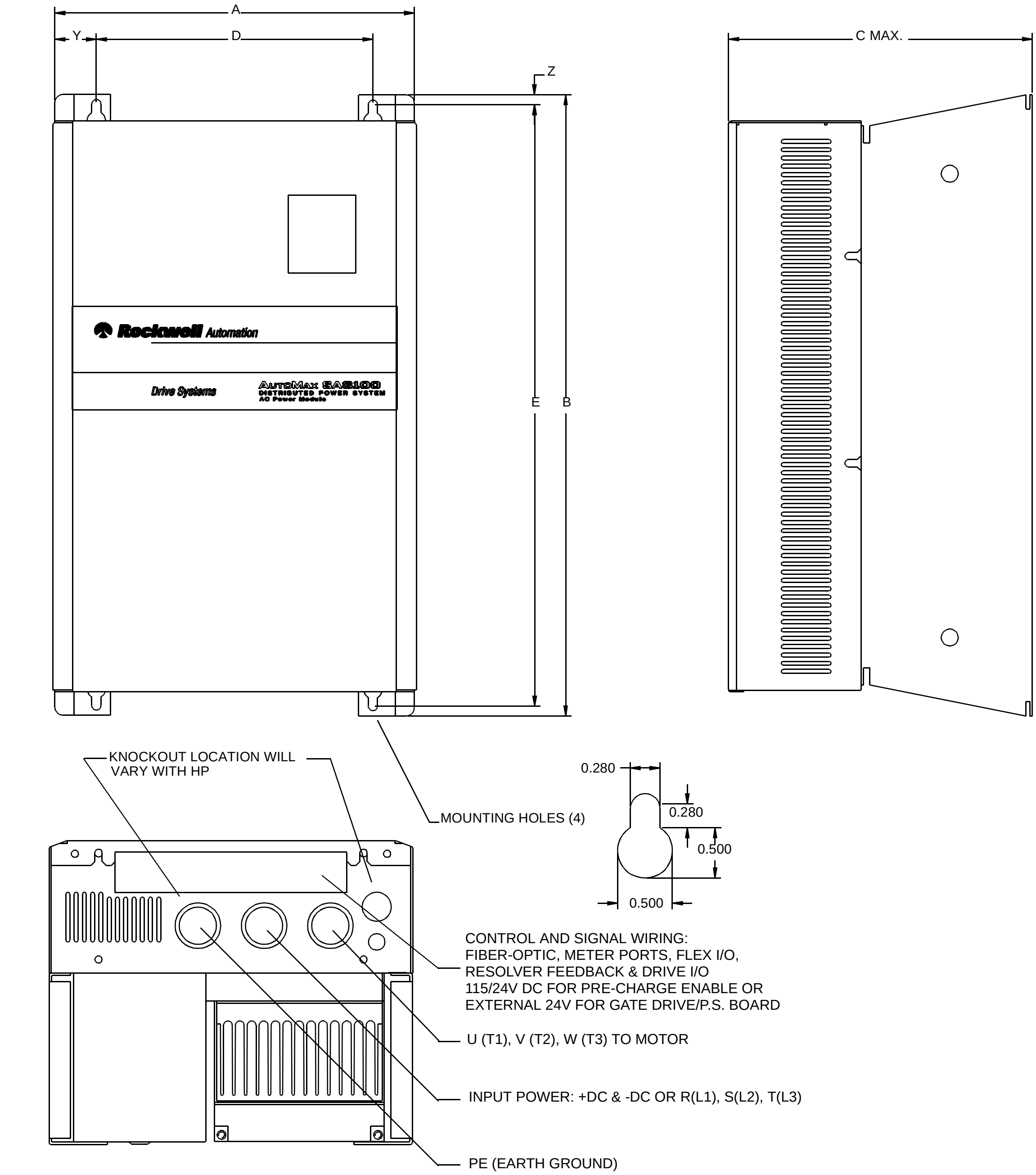
3.2 Mounting the Power Module

> **ATTENTION:** Care must be taken to prevent debris (metal shavings, conduit knockouts, etc.) from falling into the Power Module while performing any installation work on or around the Power Module.

Power Modules in enclosures must be mounted in such a way that there is sufficient space at the top, sides, and front of the cabinet to allow for heat dissipation. Allow at least 152.4 mm (6 in) above and below, and 101.6 mm (4 in) on each side between adjacent Power Modules.

Power Modules installed in user-supplied enclosures may be mounted entirely within the enclosure or may be mounted to allow the heatsink to extend outside the enclosure. Refer to Appendix A and to the enclosure manufacturer's guidelines for sizing.

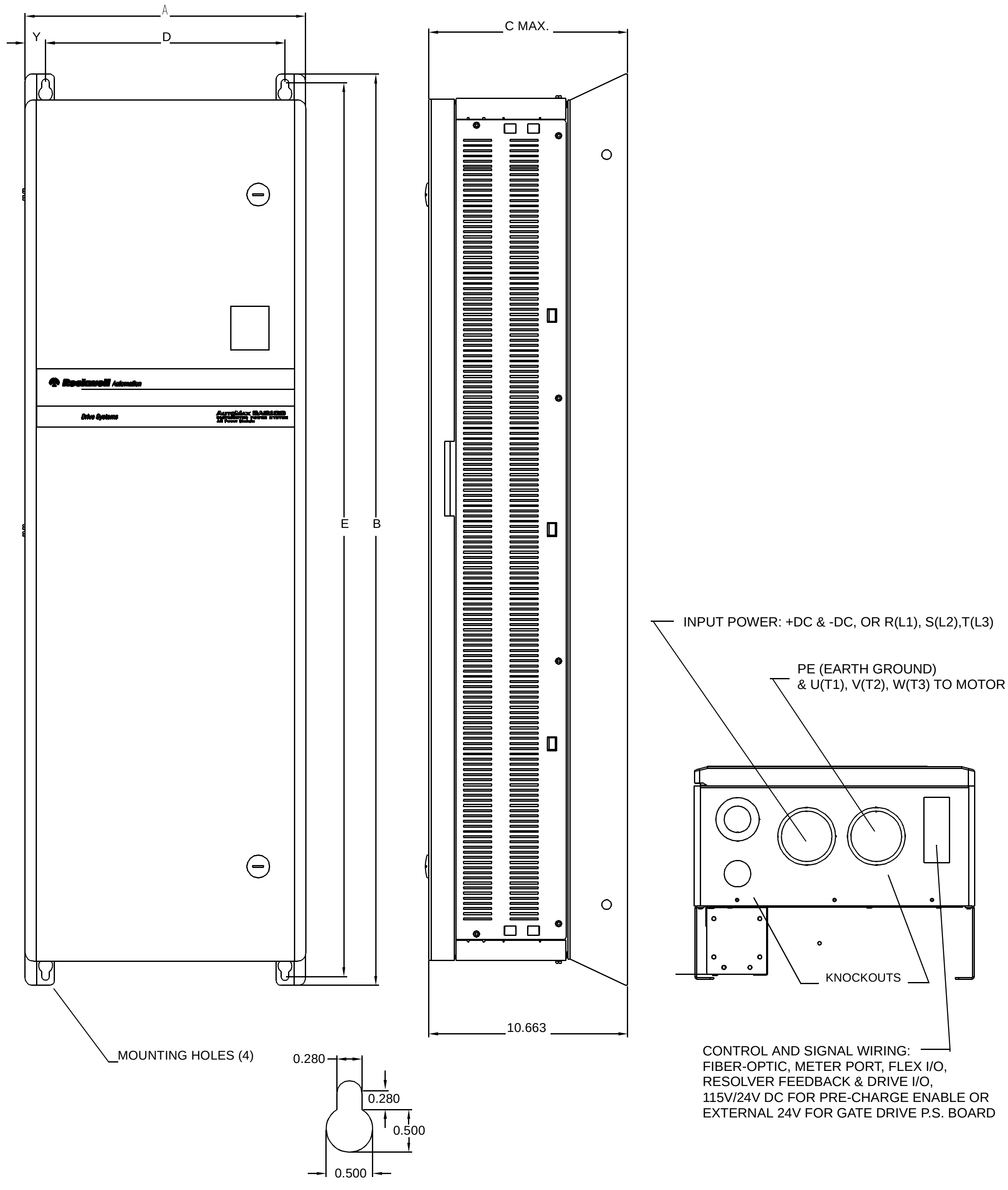
Dimensions and mounting details of Power Module frame sizes B1 through H are shown in figures 3.1 to 3.5.



ALL DIMENSIONS IN MILLIMETERS AND (INCHES)
ALL WEIGHTS IN KILOGRAMS AND (POUNDS)

FRAME REFERENCE	A	B	C MAX.	D	E	Y	Z	KNOCKOUTS 3-DUAL SIZE. 1-FIXED	SHIPPING WEIGHT
B1, B2	276.4 (10.88)	476.3 (18.75)	233.9 (9.21)	212.6 (8.37)	461.0 (18.15)	32.00 (1.26)	7.6 (0.30)	28.6/34.9, 22.2 (1.125/1.375, 0.875)	22.7 kg (50 lbs.)
C	301.8 (11.88)	701.0 (27.60)	233.9 (9.21)	238.0 (9.37)	658.8 (27.00)	32.00 (1.26)	7.6 (0.30)	28.6/34.9, 22.2 (1.125/1.375, 0.875)	38.6 kg (85 lbs.)

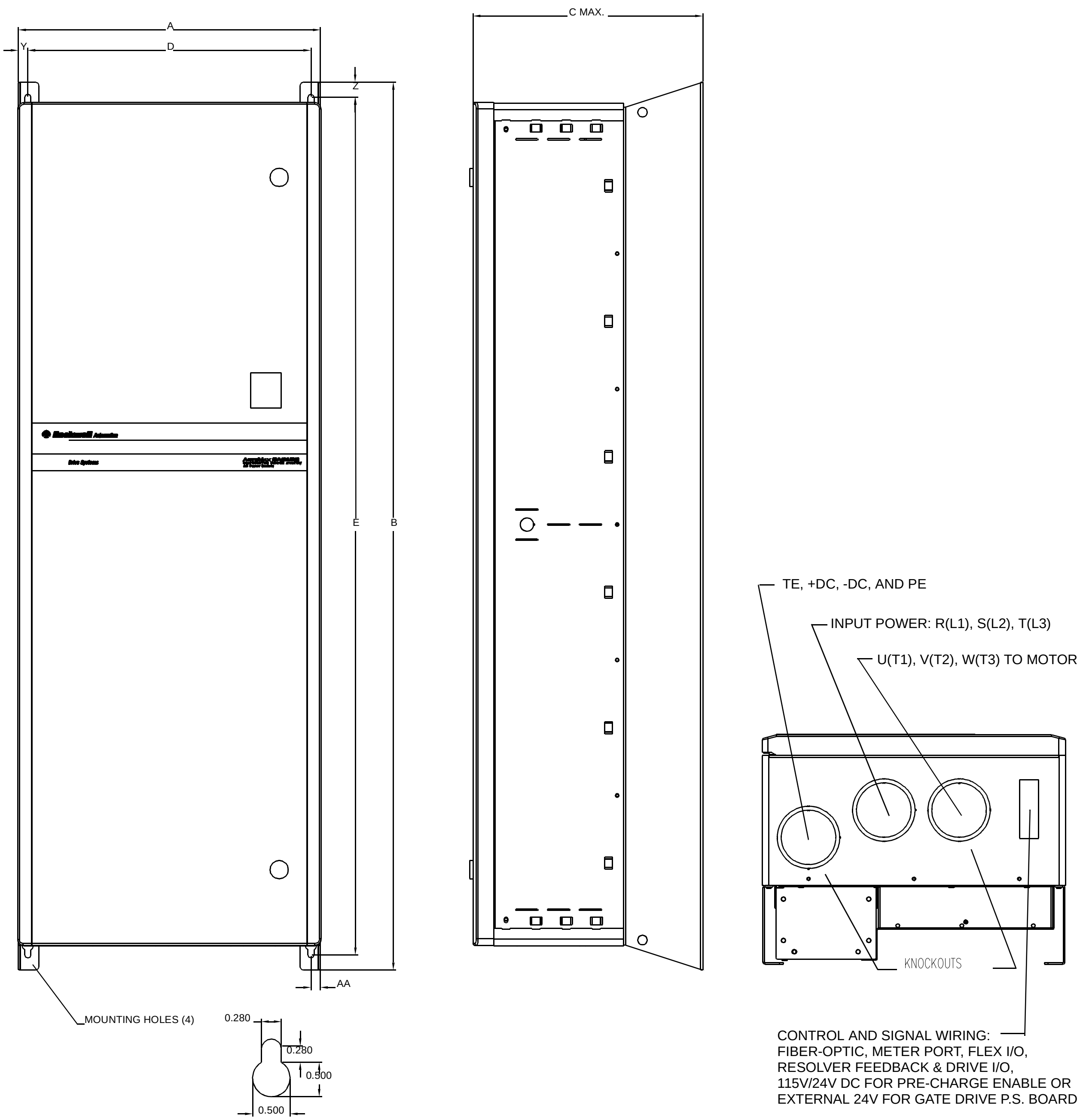
Figure 3.1 – B Frame and C Frame Dimensions



ALL DIMENSIONS IN MILLIMETERS AND (INCHES)
ALL WEIGHTS IN KILOGRAMS AND (POUNDS)

FRAME REFERENCE	A	B	C MAX.	D	E	Y	Z	KNOCKOUTS 3-DUAL SIZE. 1-FIXED	SHIPPING WEIGHT
D	381.5 (15.02)	1240.0 (48.82)	270.8 (10.66)	325.9 (12.83)	1216.2 (47.88)	27.94 (1.10)	11.94 (0.47)	62.7/76.2, 34.9/50.0, 34.9 (2.47/3.00, 1.38/1.97, 1.38)	108.9 kg (240 lbs.)

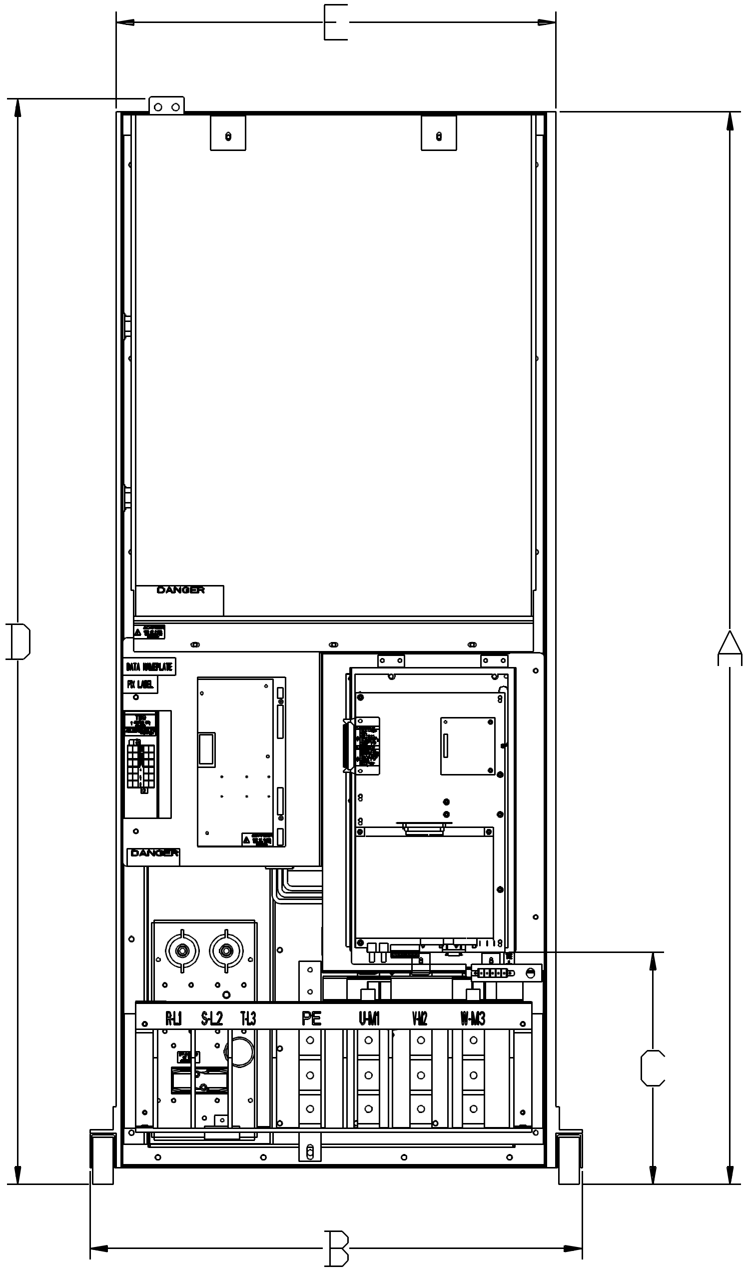
Figure 3.2 – D Frame Dimensions



ALL DIMENSIONS IN MILLIMETERS AND (INCHES)
ALL WEIGHTS IN KILOGRAMS AND (POUNDS)

FRAME REFERENCE	A	B	C MAX.	D	E	Y	Z	AA	KNOCKOUTS 3-DUAL SIZE. 1-FIXED	SHIPPING WEIGHT
E-ENCLOSED	510.0 (20.12)	1498.6 (59.00)	424.4 (16.71)	477.5 (18.80)	1447.8 (57.00)	16.8 (0.66)	40.1 (1.61)	151.9 (5.98)	92.075/104.77, 31.87,98.55 (3.625/4.125), (1.255,3.88)	186 kg (410 lbs.)
E-OPEN	510.0 (20.12)	1498.6 (59.00)	327.6 (10.66)	477.5 (18.80)	1447.8 (57.00)	16.8 (0.66)	40.1 (1.61)	126.3 (4.97)		163 kg (360 lbs.)

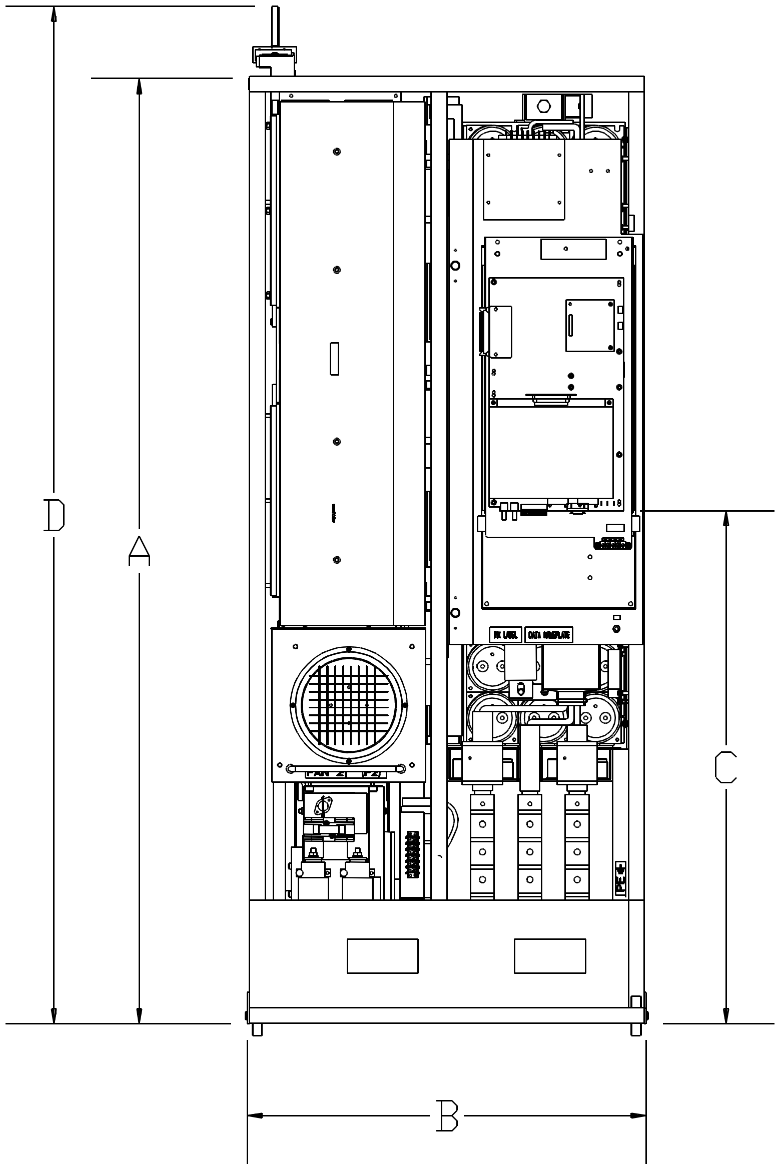
Figure 3.3 – E Frame Dimensions



ALL DIMENSIONS IN MILLIMETERS AND (INCHES)

FRAME REFERENCE	A	B	C	D	E	DEPTH
F	1524.0 (60.00)	711.2 (28.00)	335.3 (13.2)	1569.7 (61.8)	653.0 (25.00)	463.55 (18.25)

Figure 3.4 – F Frame Dimensions



FRAME REFERENCE	A	B	C	D	DEPTH
G, H	1524.0 (60.00)	653.0 (25.00)	838.2 (33.00)	1778.0 (70.00)	508.0 (20.00)

Figure 3.5 – G and H Frame Dimensions

3.3 AC Supply Source Requirements

SA3100 Power Modules are suitable for use on grounded supply circuits capable of delivering up to a maximum of 200,000 rms symmetrical amperes, 600 volts maximum, when used with the AC input line fuses specified in table 3.1. Conditioning of the AC line may be required for an unbalanced distribution system, or a system with a low impedance relative to the Power Module input.

Important: SA3100 Power Modules are designed to operate on resistance-grounded or hard-grounded distribution systems. See figure 3.11. Operation on ungrounded distribution systems is not recommended.

3.3.1 Determining if an Isolation Transformer or Line Reactor is Required

The AC line should have a minimum impedance of 1% (3% for 0.37 - 22 kW/0.5 - 30 HP drives) relative to the rated input kVA of the Power Module (see Appendix A). If the line has a lower impedance, a line reactor or isolation transformer must be added before the input to increase line impedance. If the line impedance is too low, transient voltage spikes or power interruptions could result in nuisance fuse blowing, overvoltage faults, or damage to the Power Module.

In general, an isolation transformer or line reactor (5% impedance) is required if:

- the AC line frequently experiences transient power interruptions or significant voltage spikes, or
- the kVA capacity of the AC line is greater than 4 times the kW (HP) rating of the motor, or
- the AC line has power factor correction capacitors connected, or
- the drive is operated on an unbalanced distribution system. Refer to section 3.3.2.

3.3.2 Isolating an Unbalanced Distribution System

SA3100 Power Modules are designed to operate on conventional three-phase supplies with line voltages that are symmetrical with respect to ground. The input is equipped with metal oxide varistors (MOVs) to provide voltage surge protection and line-to-line plus line-to-ground protection in conformance with IEEE 587. The MOV circuit is designed for surge suppression only (transient line protection), not continuous operation.

The Power Module should not be used directly with supplies in which the line-to-ground voltage on any phase can exceed 125% of the nominal line-to-line voltage, or on which the supply ground is tied to another system or equipment that can cause ground potential to vary. It should not be used directly with supplies in which one phase is grounded (grounded Delta).

In these cases, an isolation transformer must be installed before the drive with the neutral of the secondary grounded to provide a balanced supply.

3.4 Installing a Line Input Disconnect

ATTENTION: The NEC, CEC, and IEC require that a supply circuit disconnect be provided in the incoming power lines. Failure to observe this precaution could result in severe bodily injury or loss of life.

A supply line disconnect must be provided in the incoming power lines in accordance with NEC/CEC guidelines. Size the disconnect according to the in-rush current, as well as any additional loads the disconnect may supply. The trip rating for in-rush current (8 to 14 times the full load current) should be coordinated with that of the input isolation transformer or reactor, if used. See section 3.3.

3.5 DC Input (Common Bus) Supply Requirements

DC input Power Modules have the same power requirements as the AC equivalent models. On small (B frame) common bus Power Modules, the negative DC bus is applied to the R-L1 input (TB1-5). The positive DC bus is applied to the T-L3 input (TB1-7). See figure 3.7 and Appendix C.

On C frame and larger common bus Power Modules, the DC bus is connected directly to the DC+ and DC– terminals on terminal block TB1. See figures 3.8 to 3.10 and Appendix C.

The DC bus power for the Power Module may be supplied by a diode rectifier, a phase controlled rectifier, a synchronous rectifier, or a more complex combination of rectifiers that supply unregulated or regulated DC power to the Power Module’s DC bus. In addition, the DC bus supply may also include snubber dissipation or regenerative capability.

Prior to applying power to any Power Module, operation of the DC bus supply should be checked for proper connections, proper operation, correct voltage levels, and correct polarity at the Power Module’s termination points. Refer to the appropriate installation and setup instructions for your system’s specific equipment.

Common Bus Input Line Fuses

Common Bus Power Modules require input fuses comparable to those listed in table 3.1 in the following section. See Appendix C for detailed fuse recommendations for use with the common bus units.

3.6 Input Line Fuse Selection

ATTENTION: Use only the recommended line fuses specified in table 3.1. Branch circuit breakers or disconnect switches cannot provide this level of protection for Power Module components.

SA3100 Power Modules do not provide input power short circuit fusing. Specifications for the recommended fuse size and type to provide Power Module input power protection against short circuits are provided in table 3.1. Branch circuit breakers or disconnect switches cannot provide this level of protection for Power Module components.

Table 3.1 – Maximum Recommended Input Line Fuse Ratings

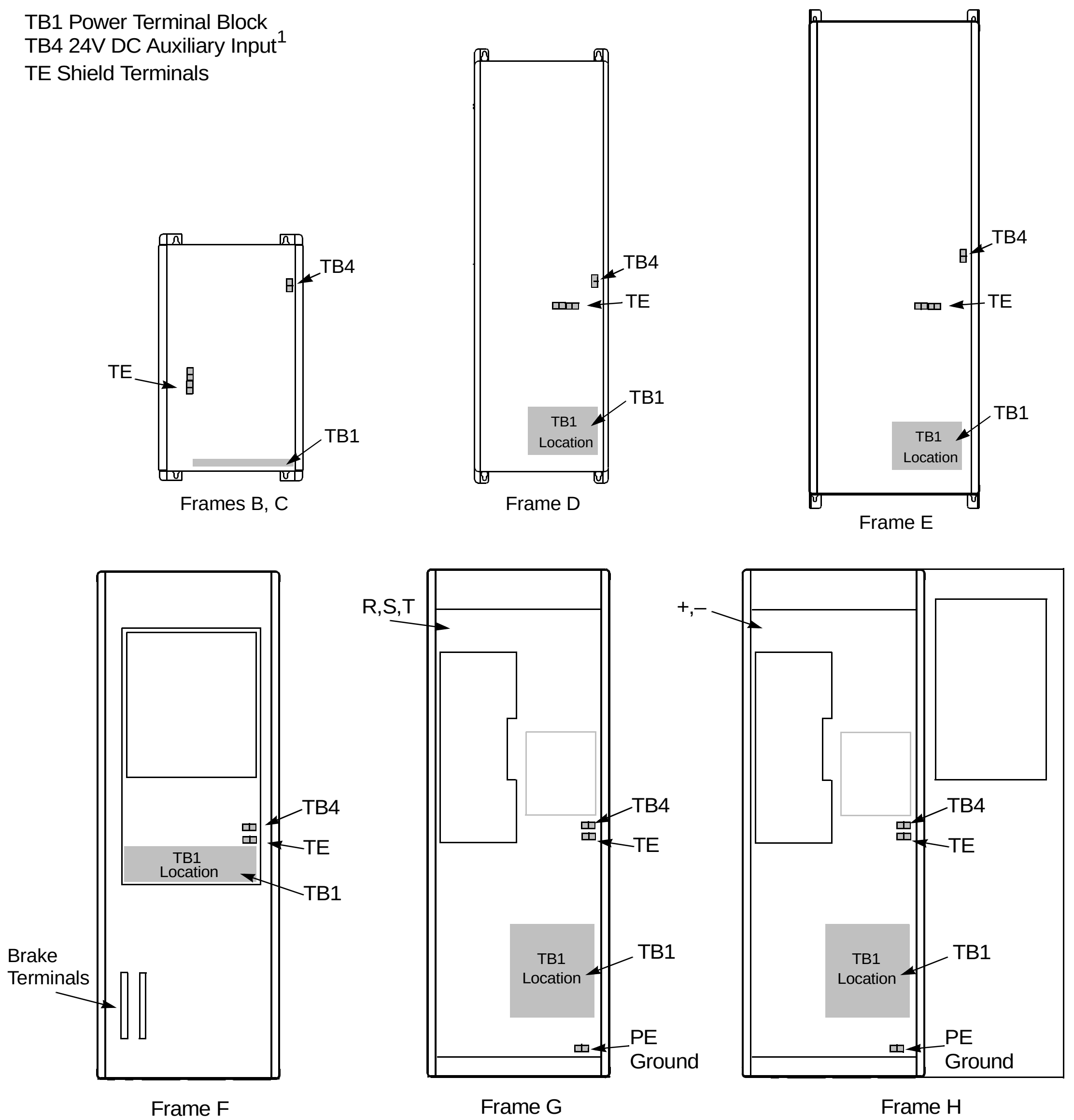
Drive Catalog No.	kW (HP) Rating	200 - 240V Rating	380 - 480V Rating	500 - 600V Rating
UL Class CC, T, J[1] - BS88 (non-UL installations)				
SA3100-_001-_ _	0.75 (1)	10A	6A	6A
SA3100-_003-_ _	2.2 (3)	15A	10A	10A
SA3100-_007-_ _	5.5 (7.5)	40A	20A	15A
SA3100-_010-_ _	7.5 (10)	50A	30A	20A
SA3100-_015-_ _	11 (15)	70A	35A	25A
SA3100-_020 -_ _	15 (20)	100A	45A	35A
SA3100-_025 -_ _	18.5 (25)	100A	60A	40A
SA3100-_030 -_ _	22 (30)	125A	70A	50A
SA3100-_040 -_ _	30 (40)	150A	80A	60A
SA3100-_050 -_ _	37 (50)	200A	100A	80A
SA3100-_060 -_ _	45 (60)	250A	125A	90A
SA3100-_075 -_ _	56 (75)	-	150A	110A
SA3100-_100 -_ _	75 (100)	-	200A	150A
SA3100-_125 -_ _	93 (125)	-	250A	175A
SA3100-_150 -_ _	112 (150)	-	300A	225A
SA3100-_200 -_ _	149 (200)	-	400A	350A
SA3100-_250 -_ _	187 (250)	-	450A	400A
Bussmann FWP/Gould Shawmut A-70C Semi-conductor Type				
SA3100-_300 -_ _	224 (300)	-	450A	400A
SA3100-_350 -_ _	261 (350)	-	500A	450A
SA3100-_400 -_ _	298 (400)	-	600A	500A
SA3100-_450 -_ _	336 (450)	-	800A	600A
SA3100-_500 -_ _	373 (500)	-	800A	800A
SA3100-_600 -_ _	448 (600)	-	900A	800A
SA3100-_650 -_ _	485 (650)	-	-	800A
SA3100-_800 -_ _	597 (800)	-	700A[2]	700A[2]

1. Both fast acting and slow blow fuses are acceptable.
2. Two fuses in parallel are required.

3.7 Power Cabling Using Terminal Block TB1

> **ATTENTION:** The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Input and output power connections are made through terminal block TB1, located on the Gate Driver board for frame size B (1 to 15 HP, 240V; 1 to 30 HP, 380V, 1 to 20 HP, 600V) Power Modules. For larger horsepower units (C through H frames), this terminal block is located near the bottom of the Power Module, where both input and output power connections are made. Refer to figure 3.6 for TB1 locations and to figures 3.7 to 3.10 for terminal identification.



1. Terminal block TB4 is an auxiliary 24V input that can be used to power the PMI Regulator when incoming AC or DC power is removed.

Figure 3.6 – Terminal Block Locations

Table 3.2 lists the TB1 signals. Wiring specifications are listed in table 3.3.

Table 3.2 – TB1 Signals

Terminal	Description
PE	Power Earth Ground
R (L1), S (L2), T (L3)	AC Line Input Terminals
+DC, -DC	DC Bus Terminals[1]
U (T1), V (T2), W (T3)	Motor Connection

1. Use terminals R (L1) and T (L3) for common bus connections in a B-frame unit (see Figure 3.7).

Table 3.3 – TB1 Wiring Specifications[1]

Drive Frame Size	Max/Min Wire Size[2] mm^2 (AWG)	Maximum Torque N-m (lb-in)
B1	8.4/0.8 (8/18)	1.81 (16)
B2	13.3/0.5 (6/20)	1.70 (15)
C	26.7/0.8 ((3/18)	5.65 (50)
D[3]	127.0/2.1 (250 MCM/14) 67.4/2.1 (00/14)[4]	6.00 (52) 6.00 (52)
E[3]	253.0/2.1 (500 MCM/14)	10.00 (87)
F[3]	303.6/2.1 (600 MCM/14)	23.00 (200)
G[3]	303.6/2.1 (600 MCM/14)	23.00 (200)
H[3]	303.6/2.1 (600 MCM/14)	23.00 (200)

1. Use 75° copper wire only.
2. Wire sizes given are maximum/minimum sizes that TB1 will accept. These are not recommendations.
3. These configurations of TB1 are stud type terminations and require the use of lug type connectors to terminate field installed conductors. Lug kits are available for use with these configurations. Wire size used is determined by selecting the proper lug kit based on the drive catalog number. Refer to table 3.4.
4. Applies to 30 kW (40 HP) 200-240V, 45 and 56 kW (60 and 75 HP) 380-480V, 56 kW (75 HP) 500-600V drives only.

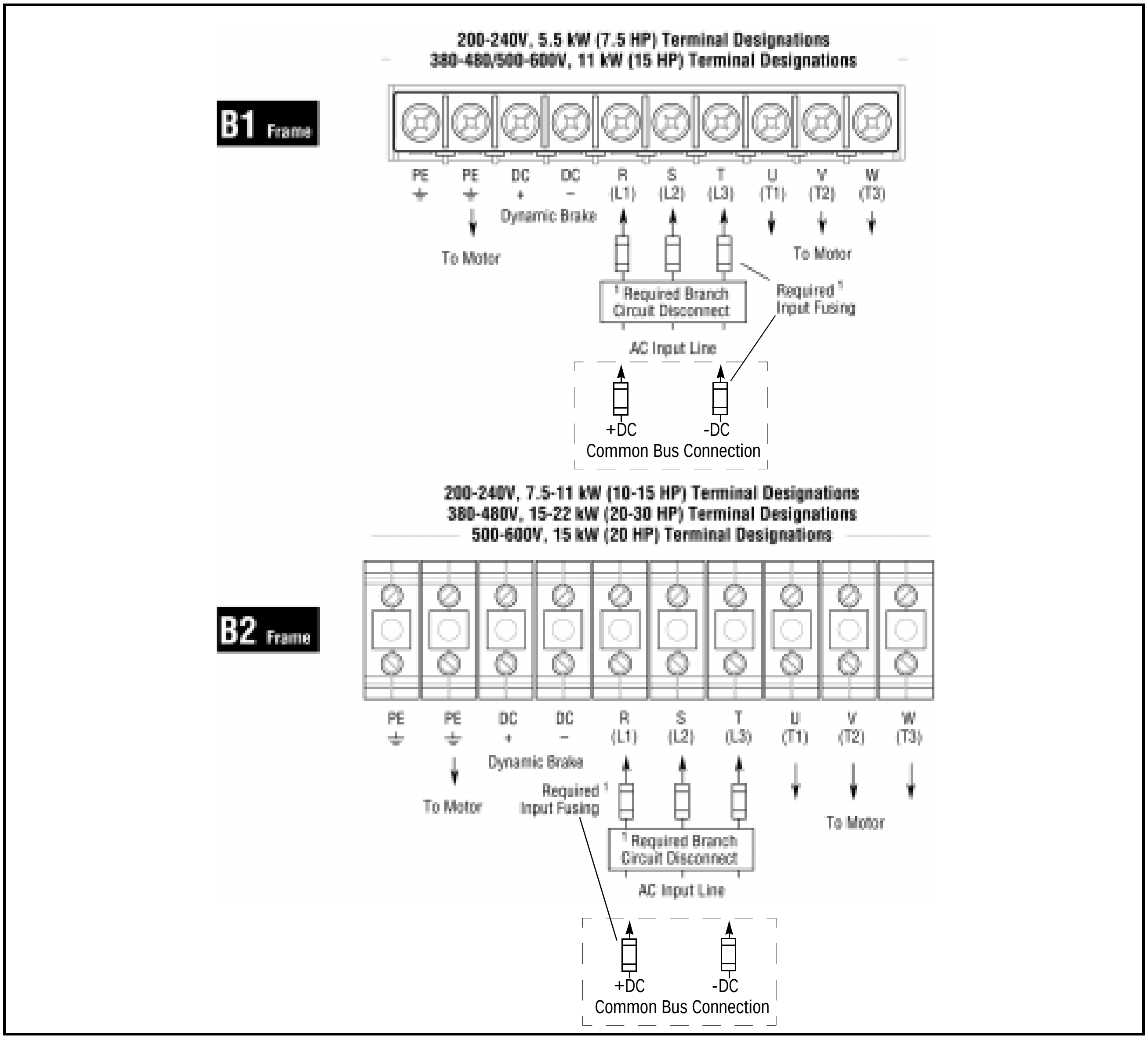


Figure 3.7 – Terminal Block TB1 (B Frame Drives)

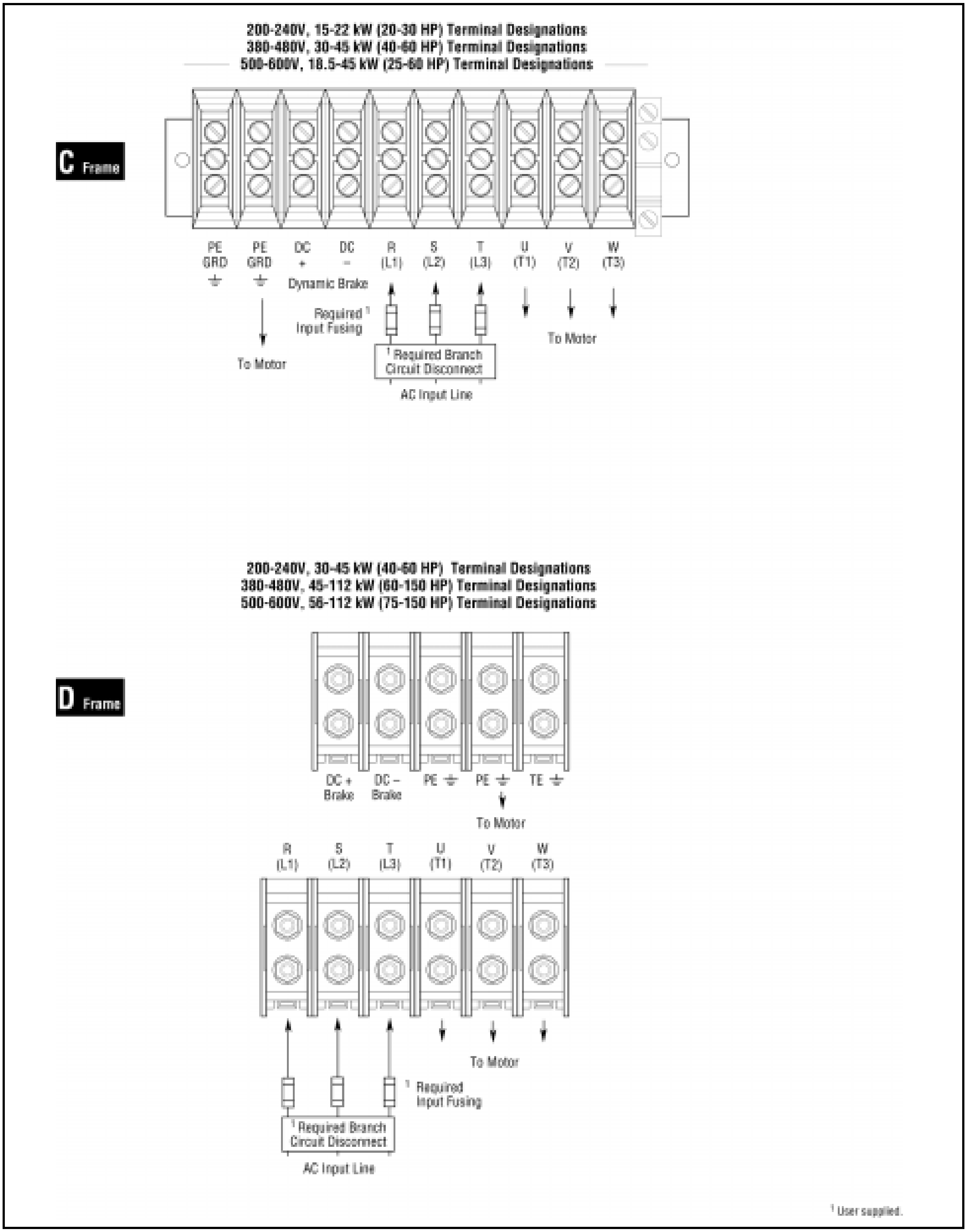


Figure 3.8 – Terminal Block TB1 (C and D Frame Drives)

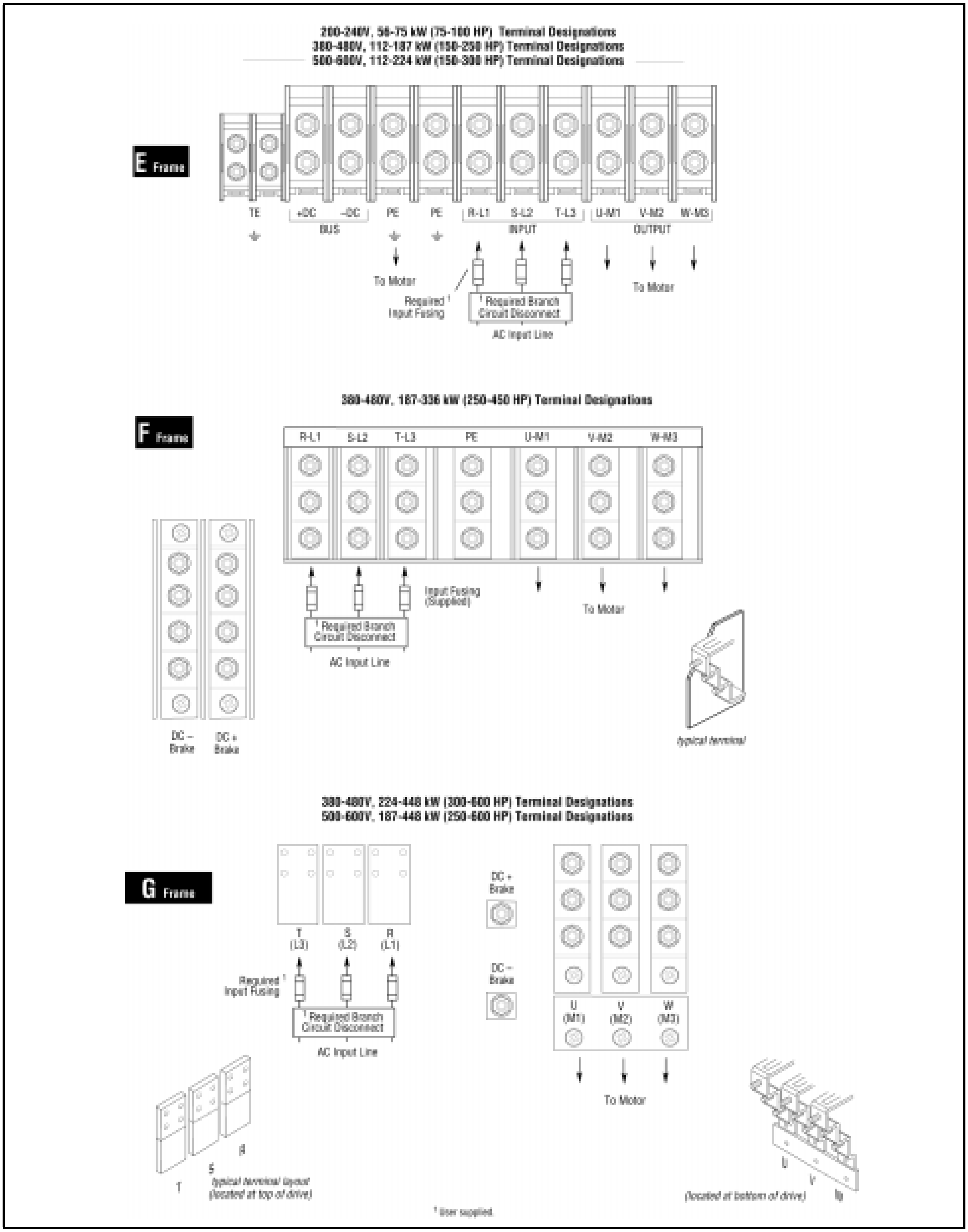


Figure 3.9 – Terminal Block TB1 (E, F, and G Frame Drives)

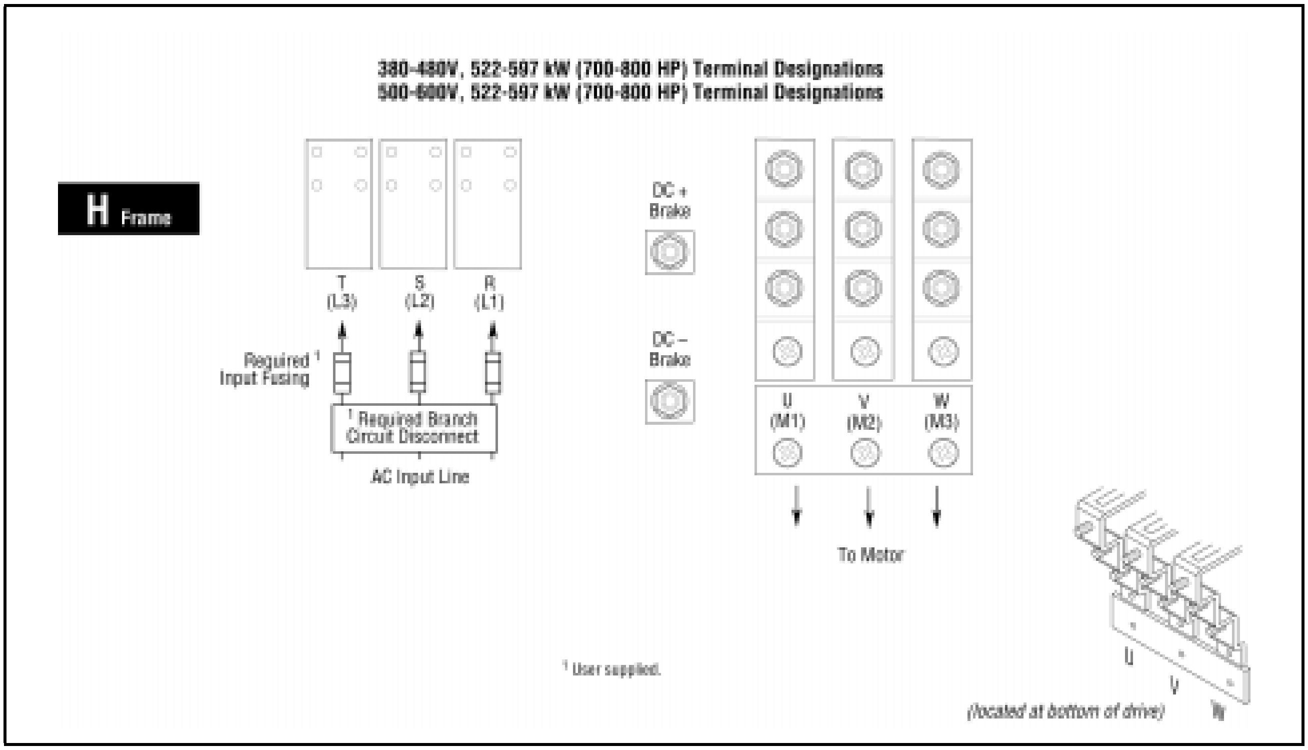


Figure 3.10 – Terminal Block TB1 (H Frame Drives)

3.8 Interlocking the Pre-charge Circuit and DC Bus Disconnect for Common Bus Units

Pre-charge circuit power on C through H frame common bus units must be interlocked with the bus disconnect. The connection is made to a 3-position terminal block identified as TB1 on the pre-charge printed circuit board. Either AC or DC control power can be used in the precharge circuit. The type of input can be selected by setting of jumper W1 (115 VAC is the default jumper setting). See figure F.2 in Appendix F.

3.9 Selecting the Proper Lug Kit for Your System

D, E, F, G, and H frame Power Modules have stud type terminals and/or bus bars/bolts that require standard crimp-type connectors for cable termination. Connectors such as T & B COLOR-KEYED® Connectors or equivalent are recommended. Table 3.4 lists the lug selection for one possible cable choice. Choose connectors for each installation based on the desired cable sizes, the application requirements, and all applicable national, state, and local codes.

Table 3.4 – Lug Selection

Power Module No.	**AC Input R,S,T Output U,V,W, and PE**				**DC+ DC-[1]**				**TE**			
	Cable (per phase)		**T&B Part No.[2]**		**Cable** (per phase)		**T&B Part No.[2]**		**Cable** (per phase)		**T&B Part No.[2]**	
	Qty	mm^2 (AWG)	Qty	Number	Qty	mm^2 (AWG)	Qty	Number	Qty	mm^2 (AWG)	Qty	Number
A/Q040	1	53.5 (1/0)	8	54153[3]	1	13.3 (6)	2	54135[3]	1	13.3 (6)	1	54135[3]
A/Q050	1	85.0 (3/0)	8	54163[3]	1	13.3 (6)	2	54135[3]	1	13.3 (6)	1	54135[3]
A/Q060	1	107.2 (4/0)	8	54168[3]	1	13.3 (6)	2	54135[3]	1	21.2 (4)	1	54139[3]
A/Q075	2	53.5 (1/0)	8 8	54109T 54109B	1	33.6 (2)	2	54109T	1	21.2 (4)	1	54139[3]
A/Q100	2	85.0 (3/0)	8 8	54111T 54111B	1	42.4 (1)	2	54148	1	33.6 (2)	1	54142[3]
A/Q125	2	107.2 (4/0)	8 8	54112T 54112B	1	67.4 (2/0)	2	54110	1	33.6 (2)	1	54142[3]
B/R060	1	42.4 (1)	8	54147[3]	1	8.4 (8)	2	54131[3]	1	13.3 (6)	1	54135[3]
B/R075	1	53.5 (1/0)	8	54153[3]	1	13.3 (6)	2	54135[3]	1	13.3 (6)	1	54135[3]
B/R100	1	85.0 (3/0)	8	54163[3]	1	13.3 (6)	2	54135[3]	1	13.3 (6)	1	54135[3]
B/R125	1	107.2 (4/0)	8	54168[3]	1	26.7 (3)	2	54147[3]	1	21.2 (4)	1	54139[3]
B/R150	2	53.5 (1/0)	8 8	54109T 54109B	1	33.6 (2)	2	54110	1	21.2 (4)	1	54139[3]
B/R200	2	85.0 (3/0)	8 8	54111T 54111B	1	42.4 (1)	2	54148	1	26.7 (3)	1	54142[3]
B/R250	2	107.2 (4/0)	8 8	54112T 54112B	1	67.4 (2/0)	2	54110	1	33.6 (2)	1	54142[3]
B/R300	3	67.4 (2/0)	24	54110	1	42.4 (1)	2	54148	N/A		N/A	
B/R350	3	85.0 (3/0)	24	54111	1	42.4 (1)	2	54148	N/A		N/A	
B/R400	3	107.2 (4/0)	24	54112	1	42.4 (1)	2	54148	N/A		N/A	
B/R450	3	127.0 (250 MCM)	24	54174	1	42.4 (1)	2	54148	N/A		N/A	
B/R500	3	152.0 (300 MCM)	24	54179	1	53.5 (1/0)	2	54109	N/A		N/A	
B/R600	3	152.0 (300 MCM)	24	54179	1	53.5 (1/0)	2	54109	N/A		N/A	
R800	-	-	-	-	4	253.0 (500 MCM)	8	54118	1	107.2 (4/0)	1	54110

Table 3.4 – Lug Selection

Power Module No.	AC Input R,S,T Output U,V,W, and PE: Cable (per phase) Qty	AC: Cable mm^2 (AWG)	AC: T&B Part No.[2] Qty	AC: T&B Part No.[2] Number	DC+ DC-[1]: Cable (per phase) Qty	DC: Cable mm^2 (AWG)	DC: T&B Part No.[2] Qty	DC: T&B Part No.[2] Number	TE: Cable (per phase) Qty	TE: Cable mm^2 (AWG)	TE: T&B Part No.[2] Qty	TE: T&B Part No.[2] Number
C/W075	1	33.6 (2)	8	54142[3]	1	13.3 (6)	2	54135[3]	1	8.4 (8)	1	54131[3]
C/W100	1	53.5 (1.0)	8	54153[3]	1	13.3 (6)	2	54135[3]	1	13.3 (6)	1	54135[3]
C/W125	1	67.4 (2/0)	8	54158[3]	1	26.7 (3)	2	54147[3]	1	13.3 (6)	1	54135[3]
C/W150	1	107.2 (4/0)	8	54111	1	42.4 (1)	2	54148	1	13.3 (6)	1	54135[3]
C/W200	2	67.4 (2/0)	8 8	54110T 54110B	1	42.4 (1)	2	54148	1	26.7 (3)	1	54142[3]
C/W250	2	85.0 (3/0)	8 8	54111T 54111B	1	67.4 (2/0)	2	54110	1	26.7 (3)	1	54142[3]
C/W300	3	85.0 (3/0)	16	54111	Consult Factory				N/A		N/A	
C/W350	3	53.5 (1/0)	24	54109					N/A		N/A	
C/W400	3	67.4 (2/0)	24	54110					N/A		N/A	
C/W450	3	85.0 (3/0)	24	54111					N/A		N/A	
C/W500	3	107.2 (4/0)	24	54112					N/A		N/A	
C/W600	3	127.0 (250 MCM)	24	54174					N/A		N/A	
W700	-	-	-	-	3	253.0 (500 MCM)	6	54118	1	67.4 (2/0)	1	54110
W800	-	-	-	-	3	253.0 (500 MCM)	6	54118	1	67.4 (2/0)	1	54110

1. Lugs show for DC+ and DC- are based on dynamic brake sizing of 50% of (motor rating x 1.25). select proper lugs based on required braking torque. Refer to instruction manuals 1336-5.64 or 1336-5.65 for additional information.
2. T & B COLOR-KEYED® Connectors require T & B W117 or TBM-6 Crimper tool or equivalent. Lugs should be crimped according to manufacturer's tool instructions. If required, Rockwell Automation can supply lug kits for lugs shown above. Kits do not include crimping tools. Consult factory for kit information.
3. 5/16 inch stud. All other studs are 3/8 inch.

3.10 Wiring Levels and Classes

Drive systems include a wide variety of electrical and electronic circuits. These range from power circuits that radiate considerable electromagnetic energy to sensitive electronic circuits susceptible to induced voltages or currents. Solid state digital logic circuits may be sensitive to transients produced by switching large currents or by close coupling of field wiring conductors unless properly protected.

System wiring is divided into four basic levels depending upon each circuit's susceptibility to noise or its noise-generating capability. The installation wiring for these levels must be physically separated to prevent poor system performance as a result of induced noise. Within each level there also may be classes that require additional grouping and separation of installation wiring. These levels and classes are defined in ANSI/IEEE Standard 518, Section 6.4.3.1 as follows:

Level 1: High Susceptibility

Level 2: Medium Susceptibility

Level 3: Low Susceptibility

Level 4: Power

Different levels must be run in separate conduit or wire trays. Classes within a level must be run in separate conduit, but may be run in the same wire trays as long as they are grouped and separated. The IEEE levels and classes are identified on the Drive Systems W/E drawings for installation wiring with slash cabling notes.

For more detailed definitions of the circuit levels based on the IEEE Standard 518-1982, and descriptions of the practices required for each level, refer to instruction manual D2-3115, *Installing, Operating, and Maintaining Engineered Drive Systems.*

3.11 Wiring Recommendations and Standard Practices

The following wiring recommendations and standard practices apply to all electrical Drive Systems equipment provided by Rockwell Automation unless superseded by other information provided by Rockwell Automation for a specific application.

3.11.1 Standard Wiring Notes

Rockwell Automation uses a set of standard notes (W/N) to help you select the proper wiring and route field-installed cabling and conduit runs. These notes include component locations and any special wiring practices that are required. The notes also identify different wire classes that must be segregated within an IEEE level.

The standard note sheets are included with W/E drawings, along with any special notes for a specific application. Refer to these documents supplied with your drive system.

3.11.2 Wiring to Drive Enclosures

Premises wiring (as defined by the NEC) entering Rockwell enclosures and panels must follow IEEE defined separation rules. This wiring should enter the enclosure at the designated conduit entry points closest to the provided terminations. These entry points are shown on the enclosure dimension sheets provided with the system. The termination locations are shown on the panel layout (W/L) drawings.

3.11.3 Notes on Control and Signal Wiring

All control and signal wiring is connected to the SA3100 Power Module through its internal PMI Regulator. Control and signal wiring of the PMI Regulator is described in instruction manual S-3057. Refer to that manual for a description of:

- Resolver and Drive I/O connections
- Flex I/O connections
- Meter Port Connections
- the UDC/PMI Regulator Fiber-optic interface

3.12 Installing an Emergency Stop

> **ATTENTION:** The user must provide an external, hardwired emergency stop circuit outside of the drive circuitry. This circuit must disable the drive system is case of improper operation. Uncontrolled machine operation may result if this procedure is not followed. Failure to observe this precaution could result in bodily injury.
>
> **ATTENTION:** SA3100 drives are controlled by input signals that start and stop the motor. A device that routinely disconnects and then reapplies power for the purpose of starting and stopping the motor must not be used.
>
> **ATTENTION:** When input power is removed, there will be a loss of inherent regenerative braking effect and the motor will coast to a stop. An auxiliary braking method may be required.

The user must provide a hardwired emergency stop external to the drive. The emergency stop circuit must contain only hardwired electromechanical components. Operation of the emergency stop must not depend on electronic logic (hardware or software) or on the communication of commands over an electronic network or link.

Note that switching the disconnect during operation, particularly opening the contacts while the drive is running, should be prevented. This can be accomplished by using the MCR output contacts in conjunction with the drive's RPI input, which will turn off the output power devices before opening the contacts.

Output contactors may be placed in series with the motor leads if the motor must be isolated from the Power Module in an emergency stop. Opening the contacts while the drive is running should be prevented.

3.13 Connecting the Motor

A variety of cable types are acceptable for SA3100 Power Module installations. For many installations, using separate conductors or unshielded cable is adequate. Signal wire for sensitive circuits must be run in separate conduit and be physically separated from inverter output cables. As an approximate guide, allow a minimum separation of 0.3 meters (1.0 ft) between cable types.

Motor cable should be 3-conductor with ground. The ground leads should be connected directly to the Power Module ground terminal (PE) and to the motor frame ground terminal.

Separation of motor leads into separate conduit or raceways is not recommended. Phase U, V, and W output leads should be grouped together in cables and/or conduit.

3.13.1 Using Shielded Cable

Shielded cable is recommended if sensitive circuits or devices are connected to, or mounted on, the machinery driven by the motor. The shield must be connected to both the drive ground (at the Power Module end) and to the motor frame ground (at the motor end) to minimize interference. See Appendix D.

If cable trays or large conduits are used to distribute the motor leads for multiple drives, shielded cable is recommended to reduce cross-coupling of noise between the leads of different drives. The shields should be connected to the ground connections at both the motor and drive ends.

Armored cable may also provide effective shielding. Ideally, armored cable should be grounded only at the Power Module (PE) and motor frame. Armored cable having a PVC coating over the armor to prevent incidental contact with a grounded structure is recommended. If the armor is grounded at the cabinet entrance, shielded cable should be used within the cabinet if power leads will be run close to control signal leads.

In some environments, such as the proximity of very high current electrical machines, it may not be not permissible to ground both ends of the cable shield. In these environments the presence of strong magnetic fields may induce high currents in the ground loop formed by the shield or cable armor and earth grounds. In such cases, consult with the factory for specific guidelines.

3.13.2 Guidelines for Using Conduit

> **ATTENTION:** To avoid a possible shock hazard caused by induced voltages, unused wires in the conduit must be grounded at both ends. If a Power Module sharing a conduit is being serviced or installed, all Power Modules using this conduit must be disabled to eliminate the possible shock hazard from cross-coupled motor leads.

If metal conduit is preferred for cable distribution, the following guidelines should be observed:

1. Power Modules are normally mounted in cabinets, and ground connections are made at a common ground point in the cabinet. Installation of conduit should provide grounded connections to both the motor frame ground (junction box) and the Power Module cabinet ground to help minimize electrical interference. These connections are for noise reduction only, and do not meet the requirements for safety grounding (section 3.14.1).
2. The number of motor leads per conduit must be minimized to reduce cross-talk. No more than one set of unshielded motor leads should be routed through a single conduit. If more than one set of motor leads per conduit is required, shielded cable must be used.

3.13.3 Maximum Motor Lead Lengths

Installations with long motor cables may require the addition of an output reactor, common mode filter, or terminator to limit voltage reflections at the motor. Refer to table D.1 in Appendix D for the maximum length of motor cable allowed for various installation techniques. For installations that exceed the recommended maximum lengths listed contact the factory.

3.14 Grounding the Drive and Motor

ATTENTION: The user is responsible for conforming with all local, national, and international codes applicable to the grounding of this equipment. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Refer to figure 3.11 for recommended grounding. The Power Module must be connected to the system ground at the power earth (PE) terminal provided on the power terminal block (TB1). Ground impedance must conform to the requirements of national and local industrial safety regulations (NEC, VDE 0160, BSI, etc.) and should be inspected and tested at appropriate and regular intervals.

Within a cabinet, a single, low-impedance ground point or ground bus bar should be used. All circuits should be grounded independently and directly. The AC supply ground conductor should also be connected directly to this ground point or bus bar.

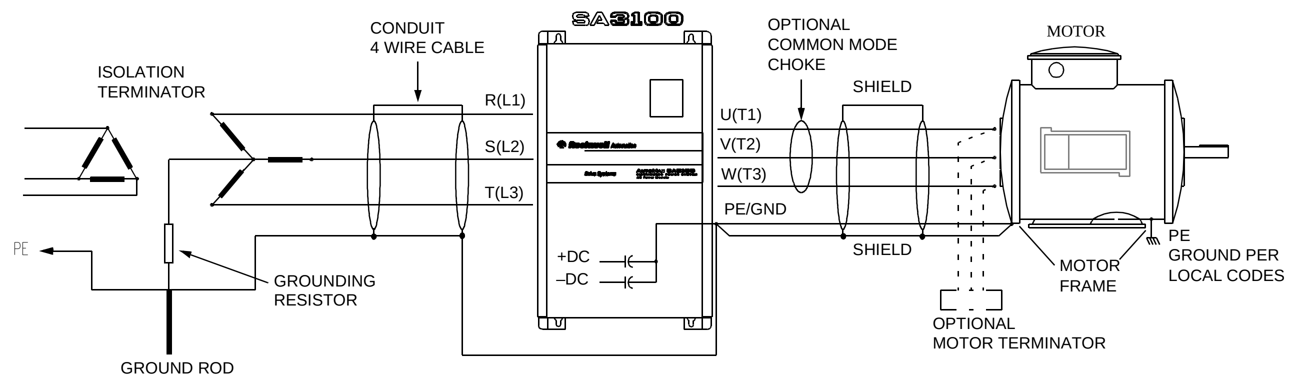


Figure 3.11 – Recommended Grounding

3.14.1 Grounding the Power Module Safety Ground (PE)

The PE (power earth) ground is the safety ground required by code. This point must be connected to adjacent building steel (girder, joist) or to a floor ground rod, provided grounding points comply with NEC regulations. If a cabinet ground bus is used, refer to section 3.5.

3.14.2 Grounding the Motor Cable

The ground conductor of the motor cable (Power Module end) must be connected directly to the Power Module earth ground terminal (PE), not to the cabinet bus bar. Grounding directly to the Power Module (and filter, if installed) provides a direct route for high frequency current returning from the motor frame and ground conductor. At the motor end, the ground conductor should be connected to the motor frame ground.

If shielded or armored cables are used, the shield/armor should be grounded at both ends as well.

3.14.3 Grounding Discrete Control Wiring

The control and signal wiring must be grounded at a single point in the system, remote from the Power Module (i.e., the 0V or ground terminal should be grounded at the equipment end, not at the drive end). If shielded control wires are used, the shield must also be grounded at this point.

Refer to the PMI Regulator instruction manual (S-3057) and to the sales order installation requirements for more information about grounding control and signal wiring.

3.14.4 Grounding Resolver/Encoder Wiring

Resolver or encoder cables must be routed in grounded steel conduit. The conduit must be grounded at both ends. Ground the cable shield at the Power Module end only.

3.14.5 Grounding Signal Wiring Shields (TE)

The TE (true earth) terminal block is provided for signal wiring shields. It must be connected to an earth ground by a separate continuous lead. This block accepts wire sizes from 0.30 mm^2 to 2.1 mm^2 (14 to 22 AWG). Maximum torque is 1.36 N-m (12 lb.-in.). Use copper wire only. See figure 3.6 for terminal block locations.

3.14.6 Protecting Sensitive Circuits from High Frequency Ground Currents

The paths through which the high frequency ground currents flow should be identified, and the area enclosed by these paths should be minimized. Sensitive circuits must not share a path with such currents. Always separate control and power cabling. Do not run control and signal ground conductors near, or parallel to, a power ground conductor.

3.14.7 Protecting the Power Module from Externally Generated Interference

Normally, no precautions beyond the guidelines provided in this manual are required to protect the Power Module from externally generated interference. It is recommended, however, that the coils of DC energized contactors associated with drives be suppressed with a diode or similar device, since they can generate large electrical transients.

In areas subject to frequent lightning strikes, additional surge suppression is advisable. Suitable MOVs should be connected between each line and ground.

3.15 Controlling Power Module Emissions

Careful attention must be given to the arrangement of power and ground connections to the Power Module in order to avoid interference with nearby sensitive equipment. The cable to the motor carries switched voltages and should be routed away from sensitive equipment. The ground conductor of the motor cable should be connected to the Power Module ground (PE) terminal directly. Connecting this ground conductor to a cabinet ground point or ground bus bar may cause high frequency current to circulate in the ground system of the enclosure. The motor end of this ground conductor must be solidly connected to the motor case ground.

Shielded or armored cable may be used to guard against radiated emissions from the motor cable. The shield or armor should be connected to the Power Module ground terminal (PE) and the motor case ground.

Common mode chokes are recommended at the Power Module output to reduce the common mode currents.

If the installation combines a Power Module with sensitive devices or circuits, it is recommended that the lowest possible Power Module PWM frequency be programmed.

3.15.1 Installing the Optional RFI Filter

If the cabling and installation recommendations given in this manual are followed, it is unlikely that radio-frequency interference problems will occur when the Power Module is used with conventional industrial electronic circuits and systems. The optional RFI filter is recommended, however, if sensitive devices or circuits are installed on the same AC supply or if the motor cable exceeds 50 meters (164 feet). Beyond this length, the capacitance to ground will increase the supply emissions.

The RFI filter should also be used if very low emission levels are essential or if conformity with standards (EN 55011, VDE0875, BSA, FCC, etc.) is required.

Important: Conformity of the Power Module and filter to any standard does not ensure that the entire installation will conform, since many other factors can affect the installation. Only direct measurements can verify total conformity.

The RFI filter is connected between the incoming AC supply line and the Power Module's AC input terminals. The filter should be installed physically close to the Power Module, on the same mounting plate if possible, using short connections. To ensure that the RFI filter is effective, the motor cable must be shielded or armored and the guidelines in this manual must be followed.

3.15.2 Grounding the RFI Filter

> **ATTENTION:** RFI filters can only be used with AC supplies that are nominally balanced with respect to ground. In some countries, three-phase supplies are connected in a three-wire configuration with one phase grounded (Grounded Delta). The filter must not be used in Grounded Delta supplies.

The optional RFI filter may produce high ground leakage currents. Surge suppression devices are incorporated into the filter to clamp line surges to a limited voltage above ground potential. The filter must be permanently installed and solidly grounded to the supply neutral. Grounding must not rely on flexible cables and should not include any form of plug or socket that would permit inadvertent disconnection. The integrity of this connection should be checked periodically.

3.16 Commissioning the Drive

> **ATTENTION:** Only qualified personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.
>
> **ATTENTION:** Hazard of electric shock exists in this Power Module. Power circuit components are floating with respect to ground. Use only approved methods of isolating test equipment when making measurements in power circuits.
>
> **ATTENTION:** Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Multiple sources of power may be connected to this Power Module. Disconnect and lock out control equipment from power sources, and discharge stored energy in capacitors before coming into contact with any equipment in this cabinet.
>
> **ATTENTION:** The Power Module contains ESD (Electro-Static Discharge) sensitive devices. Static control precautions are required when installing, testing, servicing or repairing this assembly. These precautions should be applied when working with logic boards and any components in the power section. A properly grounded wrist strap should be worn when contacting any component in the Power Module.

Working with energized industrial control equipment can be hazardous. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Multiple sources of power may be connected to this Power Module. Disconnect and lock out control equipment from power sources, and discharge stored energy in capacitors before coming into contact with any equipment in this cabinet.

During start-up it will be necessary to work in the vicinity of energized equipment. The Safety Related Practices of NFPA 70E, *Electrical Safety for Employee Workplaces* must be followed at all times. DO NOT work alone on energized equipment. Failure to observe these precautions could result in severe bodily injury or loss of life from electrical shock, burn, or unintended actuation of controlled equipment.

Note that for maintenance and setup procedures, the Power Module may be operated without a motor connected.

3.16.1 Checking the Installation with Power Off

> **ATTENTION:** DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge. Then check the voltage across the DC bus to ensure the bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

Pre-power checks are meant to identify any problems prior to applying voltage to the system. The Power Module should be checked for any damage that may have occurred during installation. Verify that all jumpers are correctly installed and that all controls are properly set. Check that all wiring external to the Power Module is accurately connected and in proper condition. Use the following checklist:

1. Verify that all external I/O wires are properly terminated. A full point-to-point continuity check should be performed on all I/O wiring connected to the Power Module.
2. Verify that the power source is properly sized and protected for your particular Power Module. Verify proper AC or DC supply voltages and DC bus polarity.
3. Verify that the incoming power connections are accurately connected and in proper condition.
4. Verify that the motor power connections are accurately connected and in proper condition. Check motor phasing. Motor phase A should be connected to Power Module output phase A, phase B to phase B, and phase C to phase C. All phases must be properly terminated. Phasing will be double checked later in this procedure.
5. Verify that the resolver feedback device is properly connected. See instruction manual S-3057.

3.16.2 Checking the Installation with Power On

> **ATTENTION:** Working with energized industrial control equipment can present hazards of electrical shock, burn, or unintended actuation of controlled equipment. The Safety Related Practices of NFPA 70, *Electrical Safety for Employee Workplaces*, must be observed at all times. Do not work alone on energized equipment.

After all pre-power checks have been completed, the incoming AC line or DC bus power may be applied. All personnel must have a thorough knowledge of the safety controls associated with the system. All persons should have a thorough understanding of the SA3100 Power Module and the associated system design before power is applied.

3.16.2.1 Checking the AC Supply

Measure the incoming line voltage between L1 and L2, L2 and L3, and L1 and L3. Set the DMM on AC Volts, highest range (1000 VAC). The input voltage should match the input voltage given on the Power Module's nameplate within +/-10%. If the voltage is out of tolerance, verify that the Power Module rating is correct for the application. If the Power Module is correctly rated, the incoming line voltage must be adjusted to within +/-10%.

3.16.2.2 Checking the DC Bus Supply

Prior to applying power to any Power Module, operation of the DC bus supply should be checked for proper connections, proper operation, correct voltage levels, and correct polarity at termination points. Refer to the appropriate installation and setup instructions for your system's specific equipment.

3.16.3 Starting the Drive

The Start-Up procedures for an AutoMax Distributed Power System SA3100 drive are described in instruction manual S-3059, *Diagnostics, Troubleshooting, and Start-Up Guidelines*. Refer to this manual for the correct procedures to start-up your drive.

CHAPTER 4

Diagnostics and Troubleshooting

> **ATTENTION:** Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.
>
> **ATTENTION:** Hazard of electric shock exists in this Power Module. Power circuit components are floating with respect to ground. Use only approved methods of isolating test equipment when making measurements in power circuits.
>
> **ATTENTION:** Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Multiple sources of power may be connected to this Power Module. Disconnect and lock out control equipment from power sources, and discharge stored energy in capacitors before coming into contact with any equipment in this cabinet.
>
> **ATTENTION:** The Power Module contains ESD (Electro-Static Discharge) sensitive devices. Static control precautions are required when installing, testing, servicing or repairing this assembly. These precautions should be applied when working with logic boards and any components in the power section. A properly grounded wrist strap should be worn when contacting any component in the Power Module.

This chapter describes the equipment needed to check the operation of the Power Module and the tests to be performed. Also included are descriptions of the Power Module faults and warnings generated by the Distributed Power System Programming Executive software. Procedures are provided for replacing fuses and sub-assemblies.

This chapter provides information to guide you in troubleshooting. The AutoMax Distributed Power System employs extensive diagnostics to aid in correcting many malfunctions that may occur in the system. This guide is designed to help you interpret the diagnostic response of the Drive when a malfunction occurs. Possible corrective measures will be explained to help you get the Drive repaired or functional as quickly as possible for most types of malfunctions.

4.1 Recommended Test Equipment

> **ATTENTION:** Potentially fatal voltages may result from improper use of an oscilloscope and other test equipment. The oscilloscope chassis may be at potentially fatal voltage if not properly grounded. Rockwell does not recommend use of an oscilloscope to directly measure high voltages. Use an isolated measuring device with a high voltage probe. Contact Rockwell Automation for recommendations.

The following equipment should be available before initiating any troubleshooting procedures:

- Digital Multimeter (DMM) capable of 1000V DC/750 VAC, with one megohm minimum input impedance.
- Clamp on Ammeter (AC/DC) with current ratings to 2X rated current output of SA3100 AC Power Module.
- Dual trace oscilloscope with differential capability, digital storage, two X10 and two X100 calibrated probes (for safe high voltage differential measurement).
- Hand-held tachometer used to monitor motor shaft speeds.

Note that for maintenance and setup procedures, the Power Module may be operated without a motor connected.

4.2 System Diagnostics

Operation of the Power Module is monitored by the PMI Regulator. Fault and warning registers (202/1202 and 203/1203) in the UDC must be used when the system detects a fault or a warning.

The fault conditions reported in the Drive Fault register result in turning off the drive. The UDC task is not stopped automatically when a drive fault occurs unless it is specifically instructed to do so in an application task. The user must ensure that the AutoMax application task tests register 202/1202 and takes appropriate action if a fault occurs.

The warnings indicated by the Drive Warning register cause no action by themselves. Any resulting action is determined by the application task. The user must ensure that the AutoMax application task monitors register 203/1203 and takes appropriate action if any of these conditions occurs.

Refer to instruction manual S-3056, *Drive Configuration and Programming*, for further details on using the Drive Fault and Drive Warning registers.

4.3 Power Module Faults (UDC Register 202/1202)

The following faults indicate a problem with the Power Module hardware or related components. If the PMI Regulator detects any of these faults, it will disable the gates of the power devices, and the motor will begin to coast to rest. The PMI Regulator will turn off the MCR output when it detects that motor current is less than 2% of the rated motor current, or within 300 msec of the occurrence of a fault even if this current level has not been reached.

Most faults are signaled by an LED indicator on the PMI Regulator. The bits in the Drive Fault register (202/1202) should be examined to determine the cause of the fault. If a fault occurs the identifying bit will set. The fault will also be recorded in the error log for the UDC task in which it occurred.

4.3.1 DC Bus Overvoltage Fault (Bit 0)

LED indicator: EXT FLT

The DC Bus Overvoltage fault bit is set if the DC bus voltage exceeds the rating of the Power Module. Error code 1018 will be displayed in the error log of the UDC task in which the fault occurred.

4.3.2 DC Bus Overcurrent Fault (Bit 1)

LED indicator: P.M. FLT

The DC Bus Overcurrent fault bit is set if the DC bus current exceeds 125% of the rated Power Module current. Error code 1020 will be displayed in the error log of the UDC task in which the fault occurred.

4.3.3 Ground Current Fault (Bit 2)

LED indicator: EXT FLT

The Ground Current Fault bit is set if ground current exceeds the rating of the Power Module. Error code 1021 will be displayed in the error log of the UDC task in which the fault occurred.

4.3.4 Instantaneous Overcurrent Fault (Bit 3)

LED indicator: P.M. FLT

The Instantaneous Overcurrent Fault bit is set if an overcurrent is detected in one of the power devices. Register 204/1204, bits 0-5, indicate which power device detected the overcurrent. Error code 1017 will be displayed in the error log of the UDC task in which the fault occurred.

4.3.5 Isolated 12V Supply Fault (Bit 4)

LED indicator: P.M. FLT

The Isolated 12V Supply Fault bit is set if the voltage level of the 12V Pulse/Tach power supply or the external LEM power supply falls below 8V. Error code 1022 will be displayed in the error log of the UDC task in which the fault occurred.

4.3.6 Charge Bus Time-Out Fault (Bit 6)

LED indicator: EXT FLT and P.M. FLT

The Charge Bus Time-Out Fault bit is set if any of the following conditions occurs:

- The DC bus is not fully charged within 10 seconds after the bus enable bit (register 100/1100, bit 4) is set
- The drive is on and feedback indicates that the pre-charge contactor has opened
- DC bus voltage is less than the value stored in the Power Loss Fault Threshold (PLT_E0%) tunable variable.
- The lack of 115VAC or 24V DC applied to the precharge module on common bus units (C through H-frame)

Error code 1024 will be displayed in the error log of the UDC task in which the fault occurred.

If this bit is set, verify that incoming power is at the appropriate level. If the power level is correct, the problem is in the Power Module.

4.3.7 Overtemperature Fault (Bit 7)

LED indicator: P.M. FLT

The Overtemperature Fault bit is set if the internal temperature of the Power Module's heatsink exceeds 100° C. Error code 1016 will be displayed in the error log of the UDC task in which the fault occurred.

4.3.8 Resolver Broken Wire Fault (Bit 8)

LED indicator: FDBK OK

The FDBK OK LED is turned off, and the Resolver Broken Wire Fault bit is set if a sine or cosine signal from the resolver is missing due to a broken wire or the resolver gain tunable (RES_GAN%) has been set too low.

4.3.9 Resolver Fault (Bit 9)

LED indicator: N/A

The Resolver Fault bit is set if a blown fuse is detected on the Resolver & Drive I/O board. This indicates the Resolver & Drive I/O board must be replaced.

4.3.10 Overspeed Fault (Bit 9)

LED indicator: EXT FLT

The Overspeed Fault bit is set if the motor's velocity exceeds the value entered as the Overspeed Trip (RPM) configuration parameter.

4.3.11 AC Power Technology Fault (Bit 11)

LED indicator: DRV RDY

The DRV RDY LED is turned off, and the AC Power Technology Fault bit is set to indicate that an error occurred in the PMI Regulator's AC power technology circuitry. Power should be recycled to allow the Regulator to clear itself and reboot. If the DRV RDY LED remains off after repeated cycling of power, check the Diagnostic Fault Code register (222/1222) for specific information.

4.3.12 PMI Regulator Bus Fault (Bit 13)

LED indicator: N/A

This fault indicates that the Resolver & Drive I/O board and the AC power control circuitry do not respond to requests from the PMI processor. This indicates a hardware failure in the PMI Regulator.

4.3.13 UDC Run Fault (Bit 14)

The UDC Run Fault bit is set if the UDC task stops while the minor loop is running in the PMI Regulator.

4.3.14 Communication Lost Fault (Bit 15)

LED indicator: COMM OK

The COMM OK LED is turned off, and the Communication Lost Fault bit is set if the fiber-optic communication between the PMI processor and the UDC module is lost due to two consecutive errors of any type.

4.4 Power Module Warnings (UDC Register 203/1203)

The PMI Regulator will check for conditions that are not serious enough to shut down the drive, but may affect its performance. If the PMI Regulator detects any of the following Power Module warning conditions, it will set the appropriate bit in the UDC Drive Warning Register (203/1203), but it will not shut down the drive. The bits in this register should be examined by the application task to determine the cause of the warning. Any resulting action is determined by the application task. No LED indicator or UDC error code is provided for drive warnings.

4.4.1 DC Bus Overvoltage Warning (Bit 0)

The DC Bus Overvoltage Warning bit is set if the D-C bus voltage rises above the configured overvoltage threshold value. The torque is automatically limited to avoid an overvoltage fault. Bit 4 of the Drive Warning Register will also be set to indicate the torque is being limited by the system.

4.4.2 DC Bus Undervoltage Warning (Bit 1)

The DC Bus Undervoltage Warning bit is set if the D-C bus voltage drops below the configured undervoltage threshold value. The torque is automatically limited to avoid a further drop in the DC bus voltage. Bit 4 of the Drive Warning Register will also be set to indicate the torque is being limited by the system.

4.4.3 Ground Current Warning (Bit 2)

The Ground Current Warning bit is set if ground current exceeds the configured ground fault current level.

4.4.4 Voltage Ripple Warning (Bit 3)

The Voltage Ripple Warning bit is set if the ripple on the DC bus exceeds the configured voltage ripple threshold value. This can be used to detect an input phase loss in the rectifier section, or for a common bus supply.

4.4.5 Reference In Limit Warning (Bit 4)

The Reference in Limit Warning bit is set if the reference to the regulator exceeds the maximum value permitted (+/- 4095), or is being limited by the system in response to an overvoltage or undervoltage warning.

4.4.6 Tuning Aborted Warning (Bit 5)

The Tuning Aborted Warning bit is set if any of the automatic tuning procedures (e.g., resolver balance and gain calibration) is not successful.

4.4.7 Over Temperature Warning (Bit 7)

The Over Temperature Warning bit is set if the internal temperature of the Power Module's heatsink exceeds 90° C.

4.4.8 Bad Gain Data Warning (Bit 8)

The Bad Gain Data Warning bit is set if an invalid local tunable variable or drive parameter has been loaded.

4.4.9 Thermistor Open Circuit Warning (Bit 9)

The Thermistor Open Circuit Warning bit is set if an open is detected in the thermistor circuit.

4.4.10 Flex I/O Communication Warning (Bit 13)

The Flex I/O Communication Warning bit is set if a Flex I/O communication problem is detected and logged in UDC registers 10/22 or 11/23.

4.4.11 CCLK Not Synchronized Warning (Bit 14)

The CCLK Not Synchronized Warning bit is set if the CCLK counters in the PMI Regulator and the UDC module are momentarily not synchronized.

4.4.12 PMI Regulator Communication Warning (Bit 15)

The PMI Regulator Communication Warning bit is set if a fiber-optic communication error is detected is detected between the PMI processor and the UDC module. Communication errors in two consecutive messages will cause a drive fault.

4.5 Where To Find Information On Replacing Power Module Components

ATTENTION: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

Qualified service personnel responsible for repairing the SA3100 drive should refer to the service manuals listed in table 1.3 before performing any maintenance or service on SA3100 drives.

Replacement parts for the SA3100 Power Modules are also listed in the spare parts catalog, Rockwell publication number 1336-6.5.

4.5.1 PMI Regulator Assembly Components

The replacement of the PMI Regulator board, Resolver and Drive I/O board, and associated components of the regulator assembly is described in the PMI Regulator instruction manual (S-3057).

APPENDIX A

Technical Specifications

Ambient Conditions

- Operating Temperature: Open chassis: 0 to 50° C (32 to 122° F)
  Enclosed chassis: 0 to 40° C (32 to 104° F).
- Storage Temperature: -40 to 70° C (-40 to 158° F).
- Relative Humidity: 5 - 95% non-condensing
- Altitude: 1000m (3300 ft) without derating
- Shock: 15g peak for 11 ms duration (+ 1.0 ms).
- Vibration: 0.0006 inches (0.152 mm) displacement. 1G peak.

Input Voltage Rating

- 200 - 240 VAC, Standalone, 3 Phase, +/-10%, nominal
- 380 - 480 VAC, Standalone, 3 Phase, +/-10%, nominal
- 500 - 600 VAC Standalone, 3 Phase, +/-10%, nominal
- 310 VDC, Common Bus, +/-10%, nominal
- 513 - 620 VDC, Common Bus, +/-10%, nominal
- 675 - 800 VDC, Common Bus, +/-10%, nominal

Input Power Rating

- 2 - 134 KVA (230V)
- 2 - 437 KVA (380V)
- 2 - 555 KVA (460V)
- 2/3 - 578/694 KVA (500/600V)

Input Frequency

- 50/60 Hz (+/-3 Hz)

Programmable Carrier Frequencies

Drive HP	Rated Carrier Frequency	Programmable Carrier Frequency Range
1-3	4 kHz	1-12 kHz
7.5-30	4 kHz	1-12 kHz
40-60	4 kHz	1-12 kHz
75-125	2 kHz	1-6 kHz
150-250	2 kHz	1-6 kHz
300-500	2 kHz	1-4 kHz
600-650	1.5 kHz	1-4 kHz
800	1.5 kHz	1-4 kHz

Standard Output Voltage

Seven frame sizes (B, C, D, E, F, G, H) are available. Each frame size is line dependent and can power a motor between the following voltages:

- 200 - 240 VAC (line dependent)
- 380 - 480 VAC (line dependent)
- 500 - 600 VAC (line dependent)

Output Current

- 2.5 - 900 A @ 620 VDC
- 2.5 - 800 A @ 775 VDC

Output Power

- 2 - 116 KVA (230V)
- 2 - 190 KVA (380V)
- 2 - 208 KVA (415V)
- 2 - 537 KVA (460V)
- 2 - 671 KVA (575V)

For information on factors that could affect the power output of the Power Module please refer to the Enclosure and Derating Guidelines of this appendix.

Output Horsepower

- 1 - 800 HP (Continuous)

Overload Capability

- Continuous: 100% Fundamental current
- 1 minute: 150% (B - G frame Power Modules)
  135% (H frame Power Modules)

Output Frequency Range

- Vector Mode: 0 - 400 Hz (limited by feedback devices)
- V/Hz Mode: 0 - 600 Hz

Output Waveform

- Sinusoidal (PWM)

Maximum Short Circuit Current Rating

- 200,000 A rms symmetrical, 600 volts (when used with AC input line fuses specified in table 3.2).

Ride Through

- 2 seconds minimum

Efficiency

- 97.5% at rated amps, nominal line volts

Ground Fault Trip Threshold

Power Module Model Numbers	Trip Level
A001 - A003 Q 001 - Q 003 B 001 - B 003 R 001 - R 003 C 001 - C 003 W 001 - W 003	20A
A 007 - A 125 Q 007 - Q 125 B 007 - B 600 R 007 - R 800 C 007 - C 650 W 007 - W 800	100A

Input/Output Current Ratings by Model Number

The input and output current ratings grouped by drive voltage rating are provided in the following table:

Table A.1 – Power Module Input/output Ratings (@ 40° C ambient)

Model Nos.	Input kVA	Input Amps	Output kVA	Output Amps
230 VAC Output Drives				
A/Q 001	2	5	2	4.5
A/Q 003	4 - 5	12	5	12
A/Q 007	10 - 12	28	11	27.2
A/Q/ 010	12 - 14	35	14	33.7
A/Q 015	17 - 20	49	19	48.2
A/Q 020	23 - 28	67	26	64.5
A/Q 025	25 - 30	73	31	78.2
A/Q 030	27 - 30	79	32	80.0
A/Q 040	43 - 51	123	48	120.3
A/Q 050	53 - 64	154	60	149.2
A/Q 060	60 - 72	174	72	180.4
A/Q 075	82 - 99	238	96	240.0
A/Q 100	100 - 120	289	116	291.4
A/Q 125	111 - 134	322	130	327.4
460 VAC Output Drives				
B/R 001	2	3	2	2.5
B/R 003	4 - 5	6	5	6.0
B/R 007	9 - 12	14	11	13.9
B/R 010	14 - 18	22	17	20.9
B/R 015	18 - 23	28	22	27.2
B/R 020	23 - 29	35	27	33.7
B/R 025	23 - 26	43	33	41.8
B/R 030	32 - 41	49	38	48.2
B/R 040	41 - 52	63	52	64.5
B/R 050	48 - 60	75	61	78.2
B/R 060	61 - 77	93	76	96.9
B/R 075	78 - 99	119	96	120.3
B/R 100	98 - 124	149	120	149.2
B/R 125	117 - 148	178	143	180.4
B/R 150	157 - 198	238	191	240.0
B/R 200	191 - 241	290	233	291.4
B/R 250	212 - 268	322	259	327.4
B/R 300	265 - 335	403	324	406.4
B/R 350	300 - 379	455	366	459.2
B/R 400	330 - 416	501	402	481.0
B/R 450	372 - 470	565	454	570.2
B/R 500	391 - 494	594	477	599.2
B/R 600	439 - 555	668	537	673.4
R 800				900.0

Table A.1 – Power Module Input/output Ratings (@ 40° C ambient)

Model Nos.	Input kVA	Input Amps	Output kVA	Output Amps
575 VAC Output Drives				
C/W 001	2 -3	3	2	2.5
C/W 003	5 - 6	6	6	6.0
C/W 007	9 - 11	10	10	9.9
C/W 010	11 - 13	12	12	12.0
C/W 015	17 - 20	19	19	18.9
C/W 020	21 - 26	25	24	23.6
C/W 025	27 - 32	31	30	30.0
C/W 030	31 - 37	36	35	34.6
C/W 040	40 - 48	46	45	45.1
C/W 050	48 - 57	55	57	57.2
C/W 060	52 - 62	60	62	61.6
C/W 075	73 - 88	84	85	85.8
C/W 100	94 - 112	108	109	109.1
C/W 125	118 - 142	137	137	138.6
C/W 150	136 - 163	157	157	159.7
C/W 200	217 - 261	251	251	252.5
C/W 250	244 - 293	282	283	283.6
C/W 300	256 - 307	296	297	298.0
C/W 350	304 - 364	351	352	353.6
C/W 400	349 - 419	403	405	406.4
C/W 450	394 - 473	455	457	459.2
C/W 500	434 - 520	501	503	505.1
C/W 600	514 - 617	594	597	599.2
C/W 650	578 - 694	668	671	673.4
W 800	639 - 767	786	797	800.0

Enclosure Requirements

Table A.2 – Enclosure Requirements

Power Module Model No.	Base Derate Amps[1]	Derating Curve[2,3]	Heat Dissipation Watts[2,3]	Heatsink Watts[2]	Total Watts[2]
230 VAC Output Drives					
A/Q 001	4.5	None	17	32	49
A/Q 003	12	None	33	72	105
A/Q 007	27	None	156	486	642
A/Q 010	34	Fig A.1	200	721	921
A/Q 015	48	Fig A.2	205	819	1024
A/Q 020	65	Fig A.3	210	933	1143
A/Q 025	78	Fig A.4	215	1110	1325
A/Q 030	80	[4]	220	1110	1330
A/Q 040	120	Fig A.5	361	1708	2069
A/Q 050	149	Fig A.6	426	1944	2370
A/Q 060	180	Fig A.7	522	2664	3186
A/Q 075	240	Fig A.8	606	2769	3375
A/Q 100	291	Fig A.9	755	3700	4455
A/Q 125	327	[4]			
460 VAC Output Drives					
B/R 001	2.5	None	15	20	35
B/R 003	6	None	23	54	77
B/R 007	14	None	91	270	361
B/R 010	21	None	103	394	497
B/R 015	27	Fig A.10	117	486	603
B/R 020	34	Fig A.1	140	628	768
B/R 025	42	Fig A.11	141	720	861
B/R 030	48	Fig A.2	141	820	961
B/R 040	65	Fig A.3	175	933	1108
B/R 050	78	Fig A.4	193	1110	1303
B/R 060	97	[4]	361	1708	2069
B/R 075	120	Fig A.12	361	1708	2069
B/R 100	150	Fig A.13	426	1944	2370
B/R 125	180	Fig A.14	522	2664	3186
B/R 150	240	Fig A.8	606	2769	3375
B/R 200	291	Fig A.9	755	3700	4455
B/R 250	327	Fig A.15	902	4100	5002
B/R 300	406	[4]	1005	4805	5810
B/R 350	459	[4]	1055	5455	6510
B/R 400	505	[4]	1295	6175	7470
B/R 450	570	[4]	1335	6875	8210
B/R 500	599	Fig A.16	1395	7800	9200
B/R 600	673	Fig A.17	1485	8767	10252
R 800	900	[4]	N/A	N/A	N/A

Table A.2 – Enclosure Requirements

Power Module Model No.	Base Derate Amps[1]	Derating Curve[2,3]	Heat Dissipation Watts[2,3]	Heatsink Watts[2]	Total Watts[2]
575 VAC Output Drives					
C/W 001	2.5	4	4	4	4
C/W 003	6	4	4	4	4
C/W 007	10	4	91	217	308
C/W 010	12	4	103	251	354
C/W 015	19	4	117	360	477
C/W 020	24	4	140	467	607
C/W 025	30	4	141	492	633
C/W 030	35	4	141	526	667
C/W 040	45	4	175	678	853
C/W 050	57	4	193	899	1092
C/W 060	62	4	193	981	1174
C/W 075	87	Fig A.18	361	1553	1894
C/W 100	109	Fig A.19	426	1978	2504
C/W 125	138	Fig A.20	522	2162	2683
C/W 150	160	Fig A.21	4	4	4
C/W 200	252	Fig A.22	755	3065	3820
C/W 250	284	Fig A.23	890	3625	4515
C/W 300[5]	298	None	926	5015	5941
C/W 350[5]	354	None	1000	5935	6935
C/W 400[5]	406	Fig A.24	1430	7120	8550
C/W 450[5]	460	Fig A.25	1465	8020	9485
C/W 500[5]	505	Fig A.26	1500	8925	10425
C/W 600[5]	600	Fig A.27	1610	10767	12377
C/W 650[5]	673	Fig A.28	1700	12000	14000
W 800	800	None			

1. Base Amps with nominal input voltage (240, 480, or 600V). If input voltage exceeds rating, drive output must be derated. Refer to figure A.30.
2. Drive ambient temperature rating is 40° C. If ambient temperature exceeds 40° C, the drive must be derated. Refer to figures A.1 to A.28.
3. Drive rating is based on altitudes of 100 m (3300 ft) or less. If installed at a higher altitude, drive must be derated. Refer to figure A.29.
4. Not available at time of publication.
5. **Important:** Two (2) 725 CFM fans are required if an open type drive is mounted in a user-supplied enclosure.

Derating Guidelines

Standard rating for enclosed drive in 40º C ambient and open drive in 50º C ambient.

Derating factor for enclosed drive in ambient temperature between 41º C and 50º C.

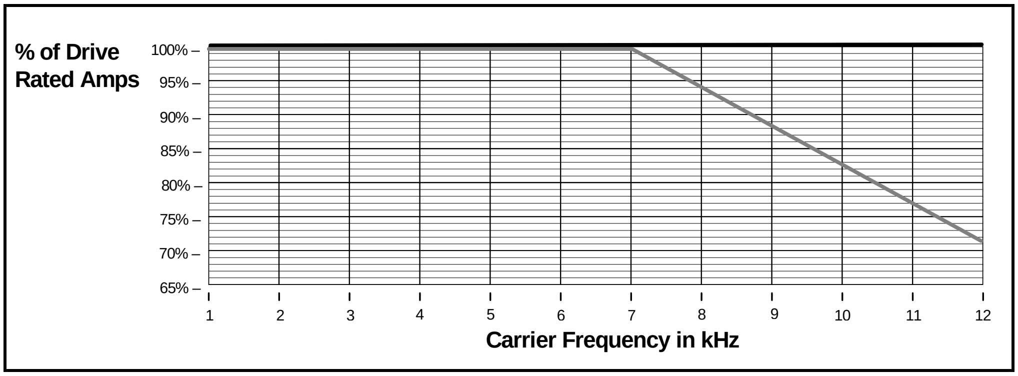


Figure A.1 – Power Modules A/Q010 and B/R020

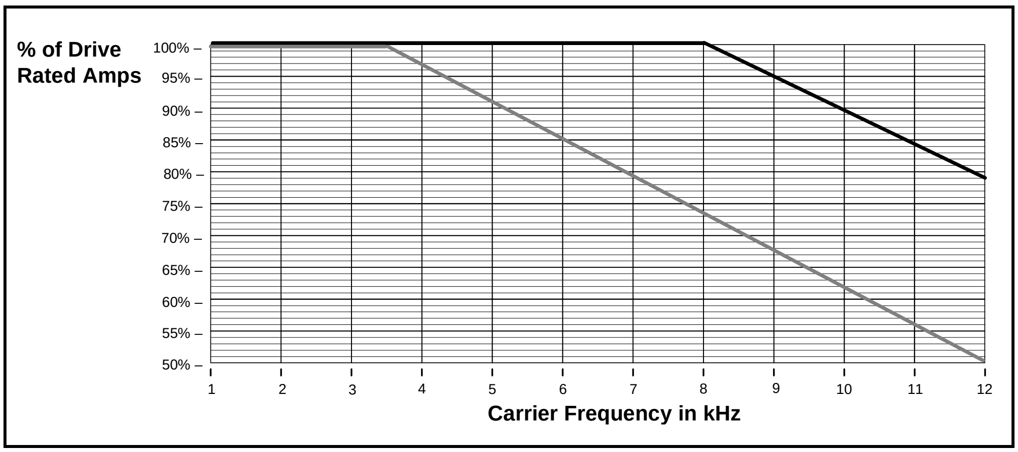


Figure A.2 – Power Modules A/Q015 and B/R030

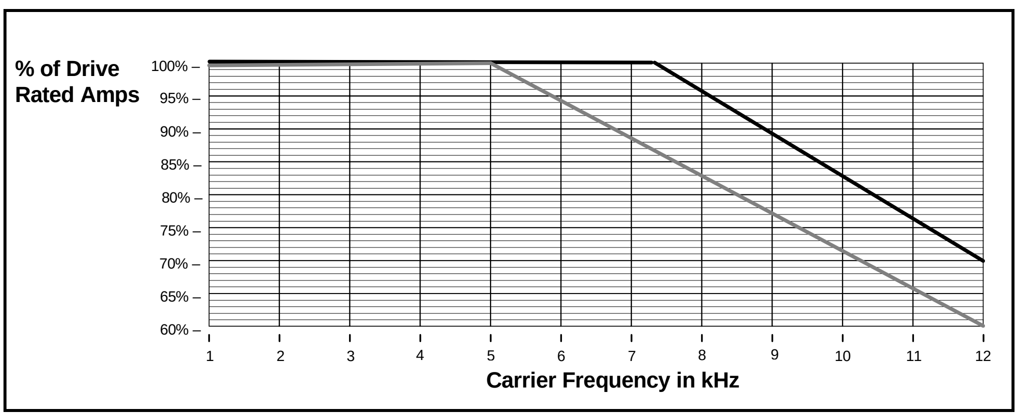


Figure A.3 – Power Modules A/Q020 and B/R040

Standard rating for enclosed drive in 40º C ambient and open drive in 50º C ambient.

Derating factor for enclosed drive in ambient temperature between 41º C and 50º C.

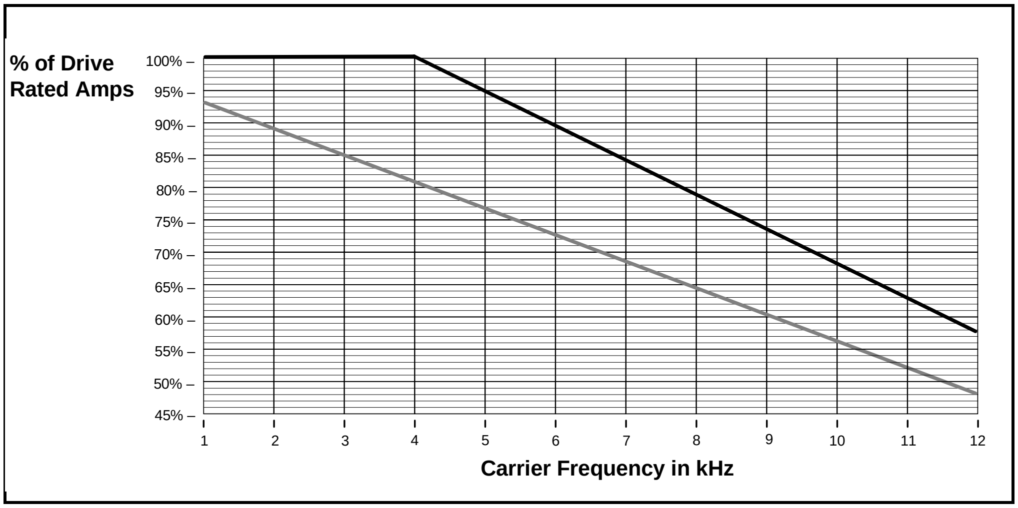


Figure A.4 – Power Module A/Q025 and B/R050

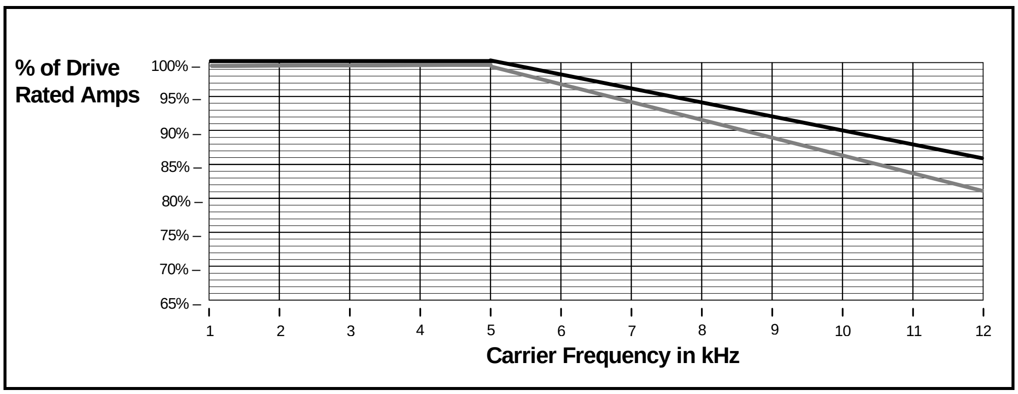


Figure A.5 – Power Modules A/Q040

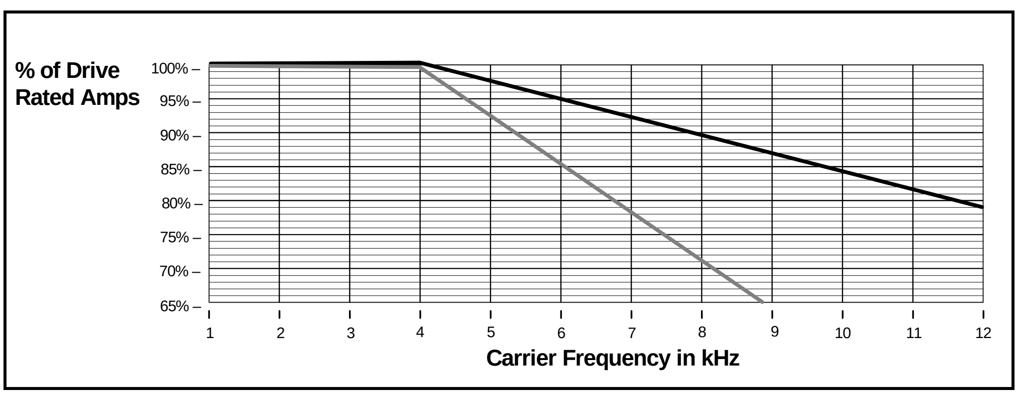


Figure A.6 – Power Modules A/Q050

Standard rating for enclosed drive in 40º C ambient and open drive in 50º C ambient.

Derating factor for enclosed drive in ambient temperature between 41º C and 50º C.

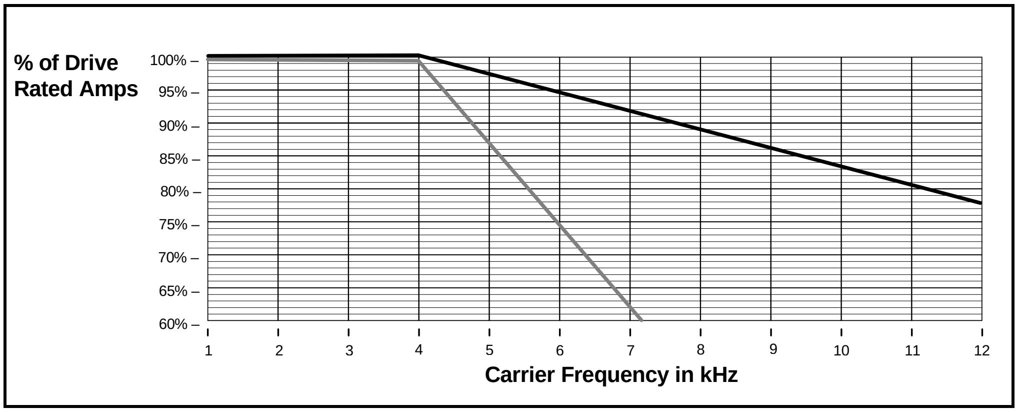


Figure A.7 – Power Module A/Q060

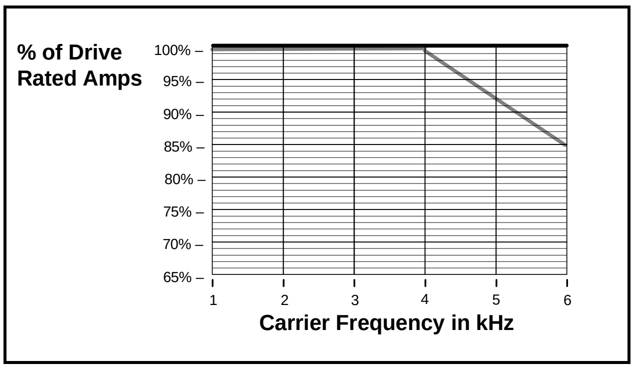


Figure A.8 – Power Modules A/Q075 and B/R150

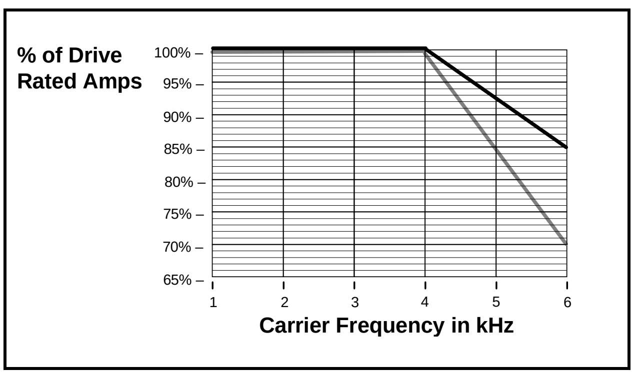


Figure A.9 – Power Modules A/Q100 and B/R200

Standard rating for enclosed drive in 40º C ambient and open drive in 50º C ambient.

Derating factor for enclosed drive in ambient temperature between 41º C and 50º C.

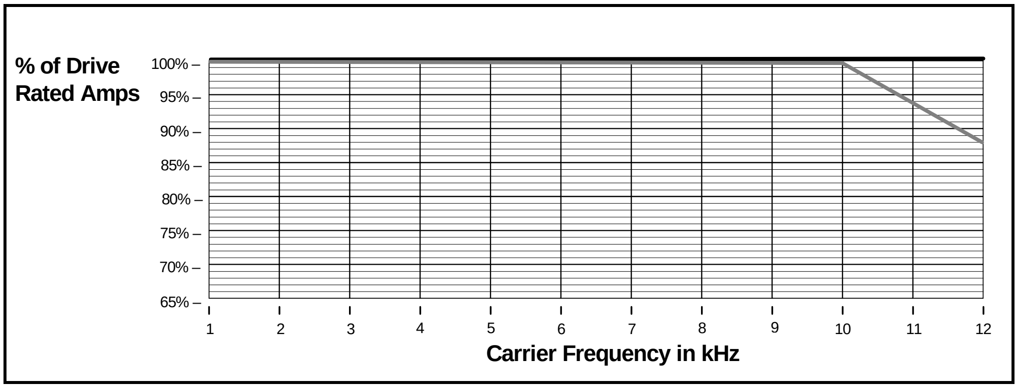


Figure A.10 – Power Modules B/R015

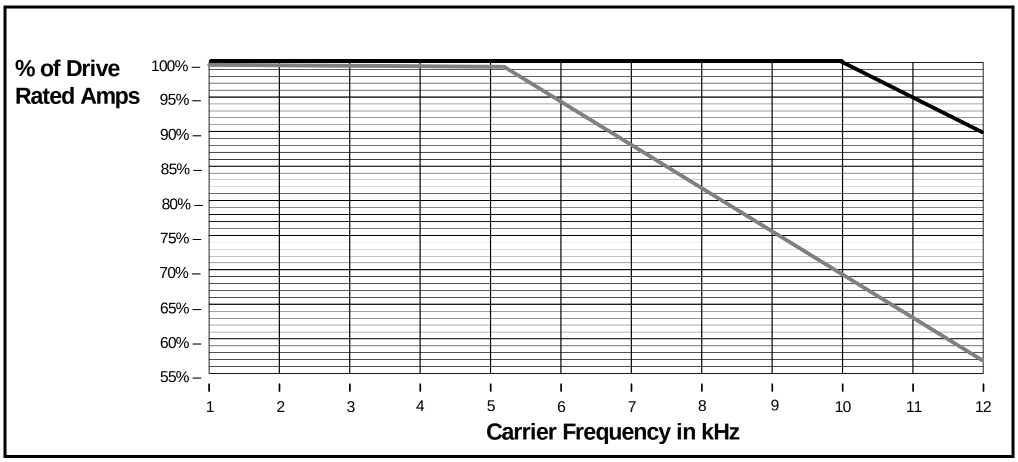


Figure A.11 – Power Modules B/R025

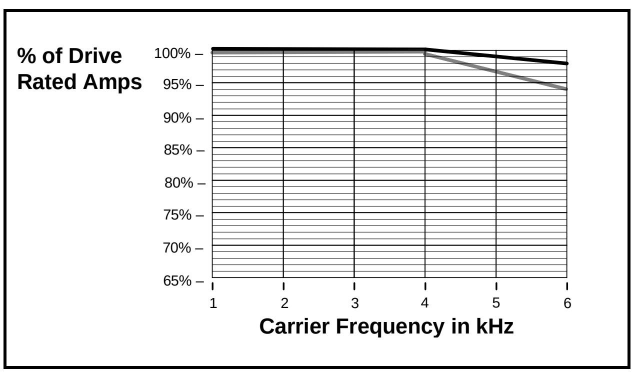


Figure A.12 – Power Module B/R075

Standard rating for enclosed drive in 40º C ambient and open drive in 50º C ambient.

Derating factor for enclosed drive in ambient temperature between 41º C and 50º C.

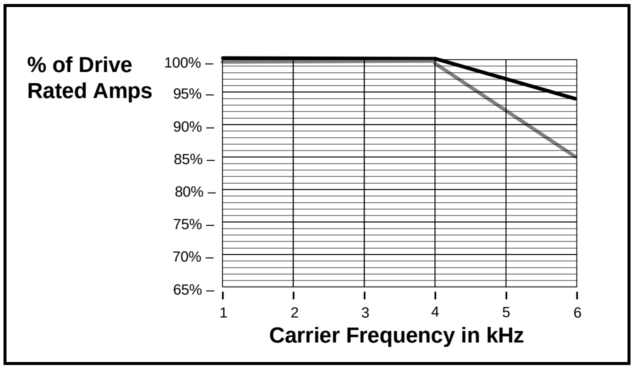


Figure A.13 – Power Modules B/R100

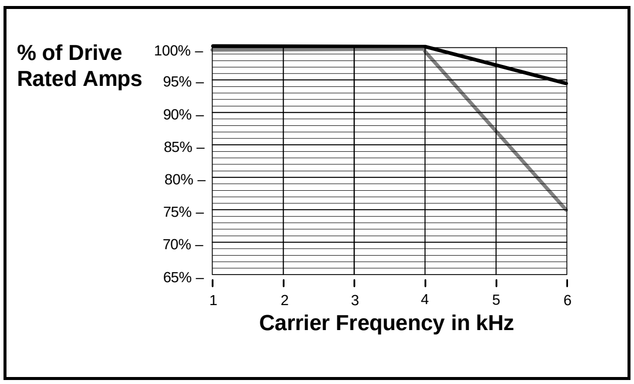


Figure A.14 – Power Modules B/R125

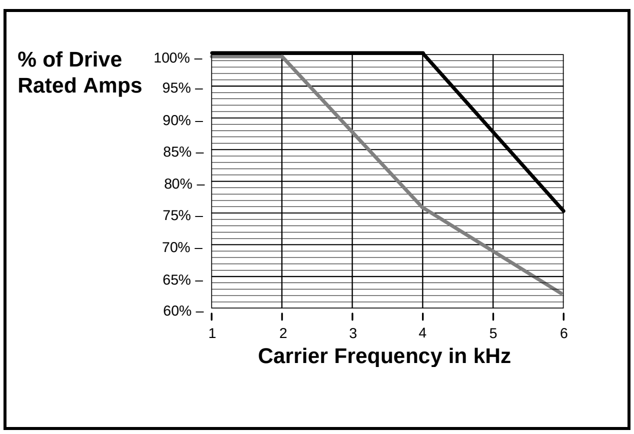


Figure A.15 – Power Module B/R250

Standard rating for enclosed drive in 40º C ambient and open drive in 50º C ambient.

Derating factor for enclosed drive in ambient temperature between 41º C and 50º C.

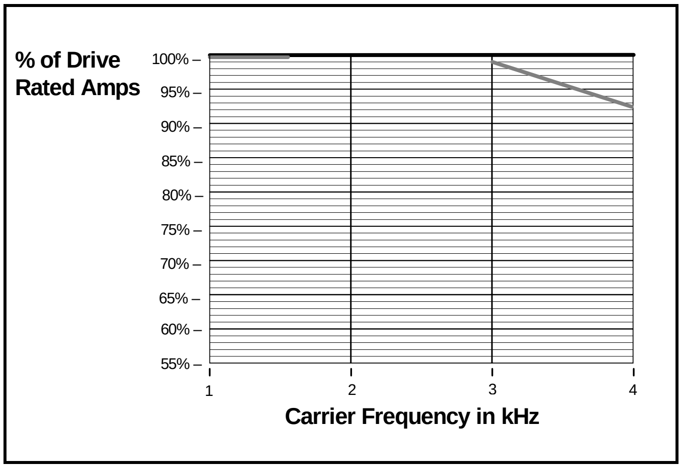


Figure A.16 – Power Module B/R500

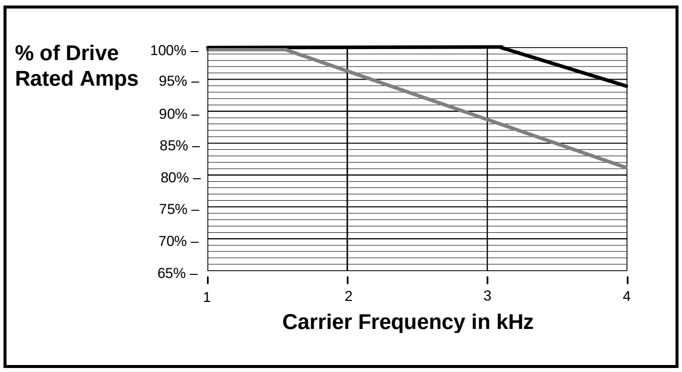


Figure A.17 – Power Modules B/R600

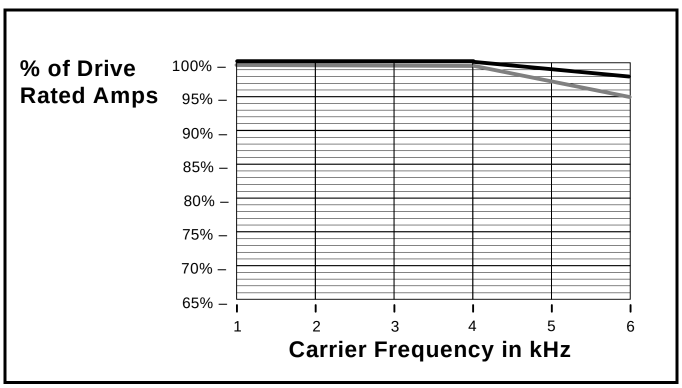


Figure A.18 – Power Modules C/W075

Standard rating for enclosed drive in 40º C ambient and open drive in 50º C ambient.

Derating factor for enclosed drive in ambient temperature between 41º C and 50º C.

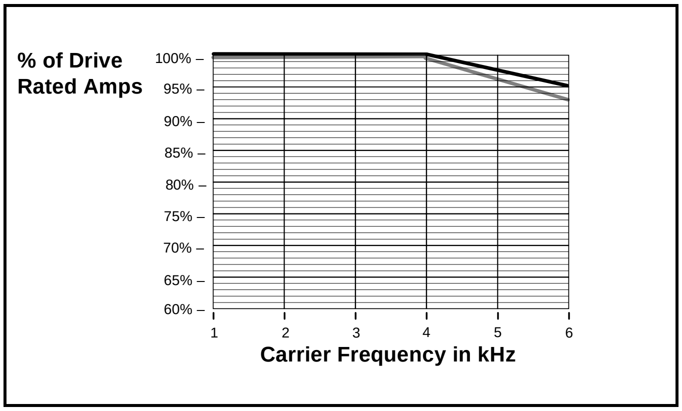


Figure A.19 – Power Modules C/W100

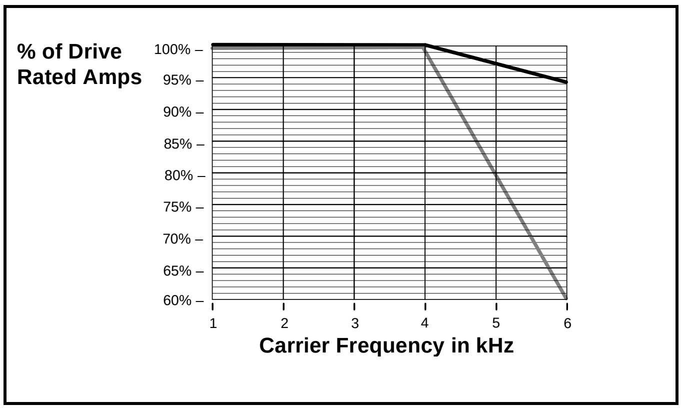


Figure A.20 – Power Module C/W125

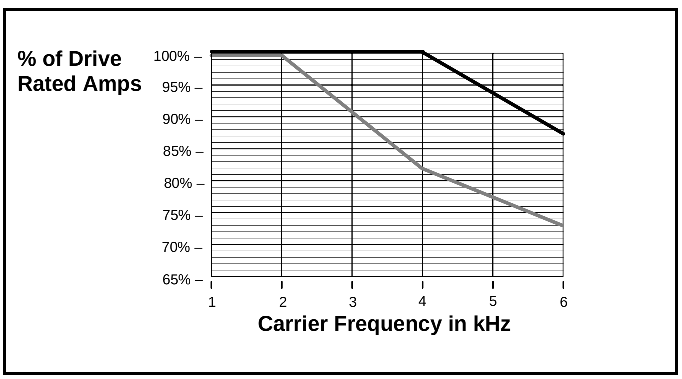


Figure A.21 – Power Module C/W150

Standard rating for enclosed drive in 40º C ambient and open drive in 50º C ambient.

Derating factor for enclosed drive in ambient temperature between 41º C and 50º C.

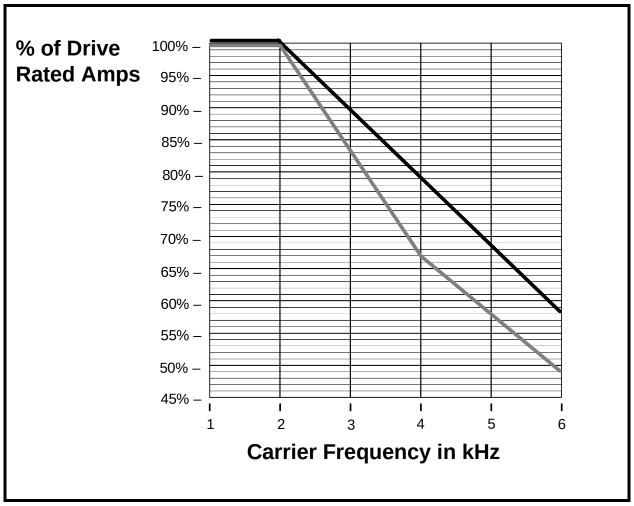


Figure A.22 – Power Module C/W200

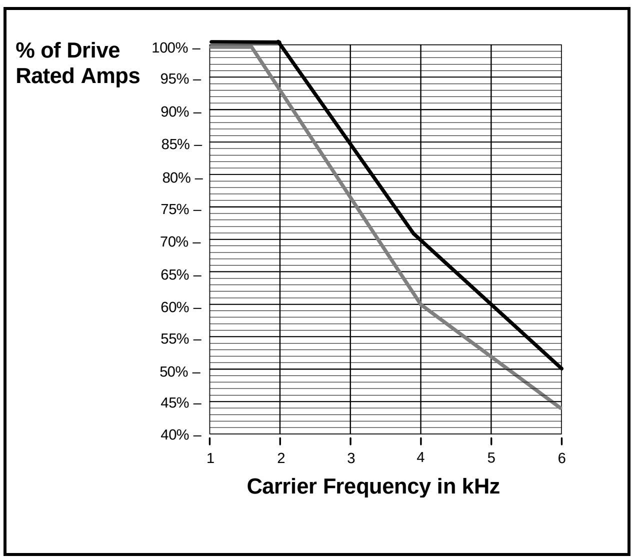


Figure A.23 – Power Module C/W250

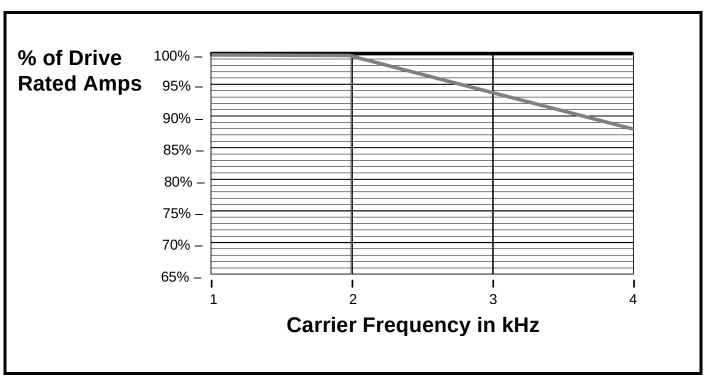


Figure A.24 – Power Module C/W400

Standard rating for enclosed drive in 40º C ambient and open drive in 50º C ambient.

Derating factor for enclosed drive in ambient temperature between 41º C and 50º C.

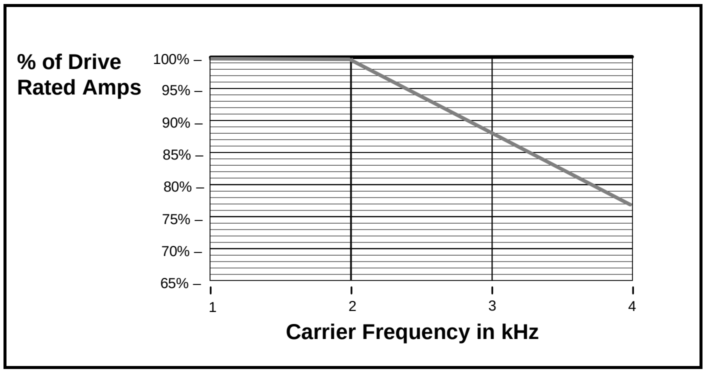


Figure A.25 – Power Modules C/W450

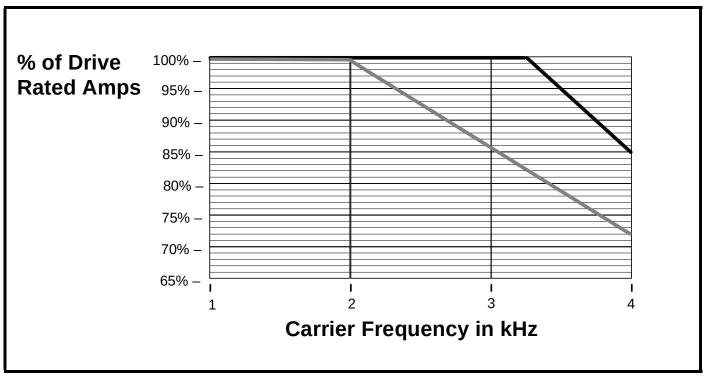


Figure A.26 – Power Modules C/W500

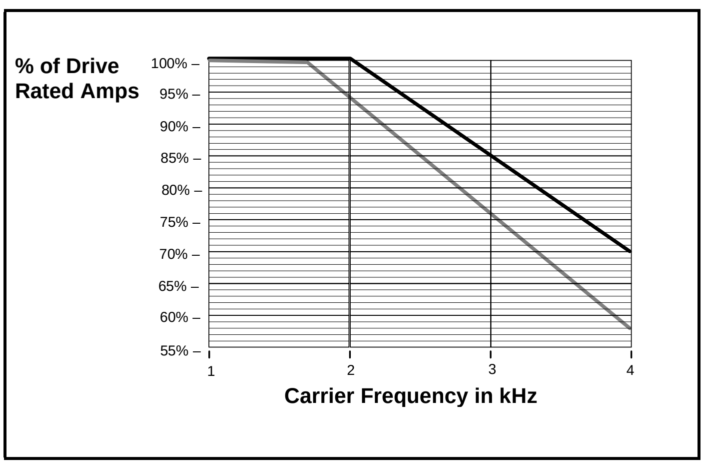


Figure A.27 – Power Modules C/W600

Standard rating for enclosed drive in 40º C ambient and open drive in 50º C ambient.

Derating factor for enclosed drive in ambient temperature between 41º C and 50º C.

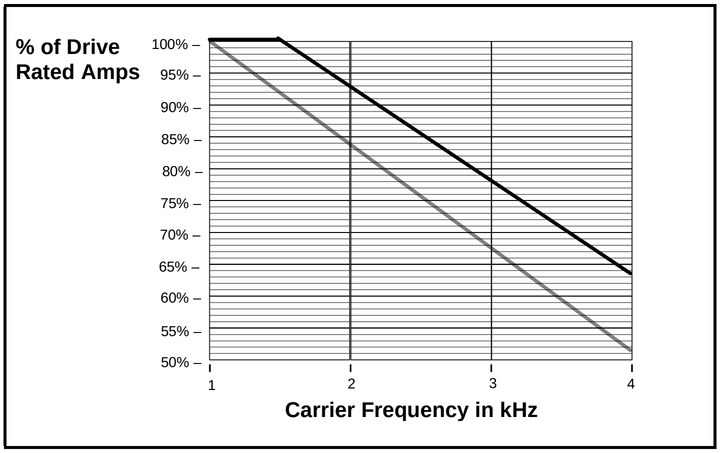


Figure A.28 – Power Modules C/W650

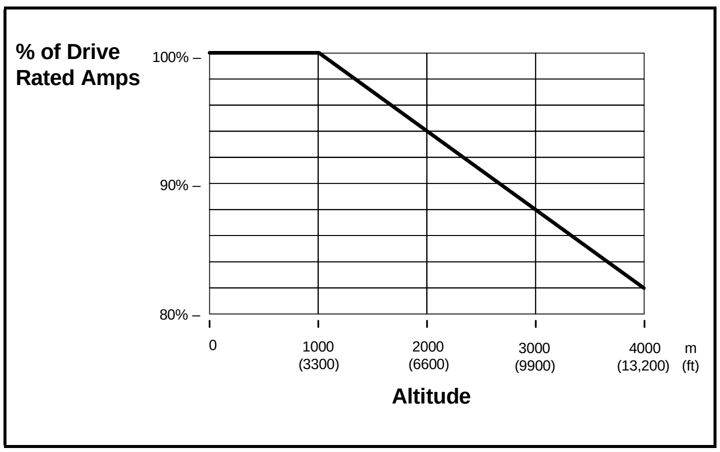


Figure A.29 – Altitude Derating (All Power Modules)

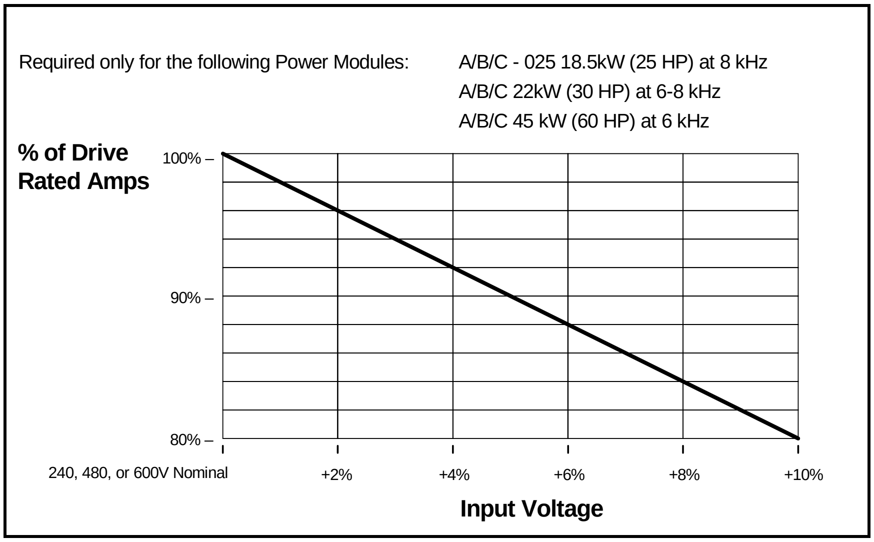
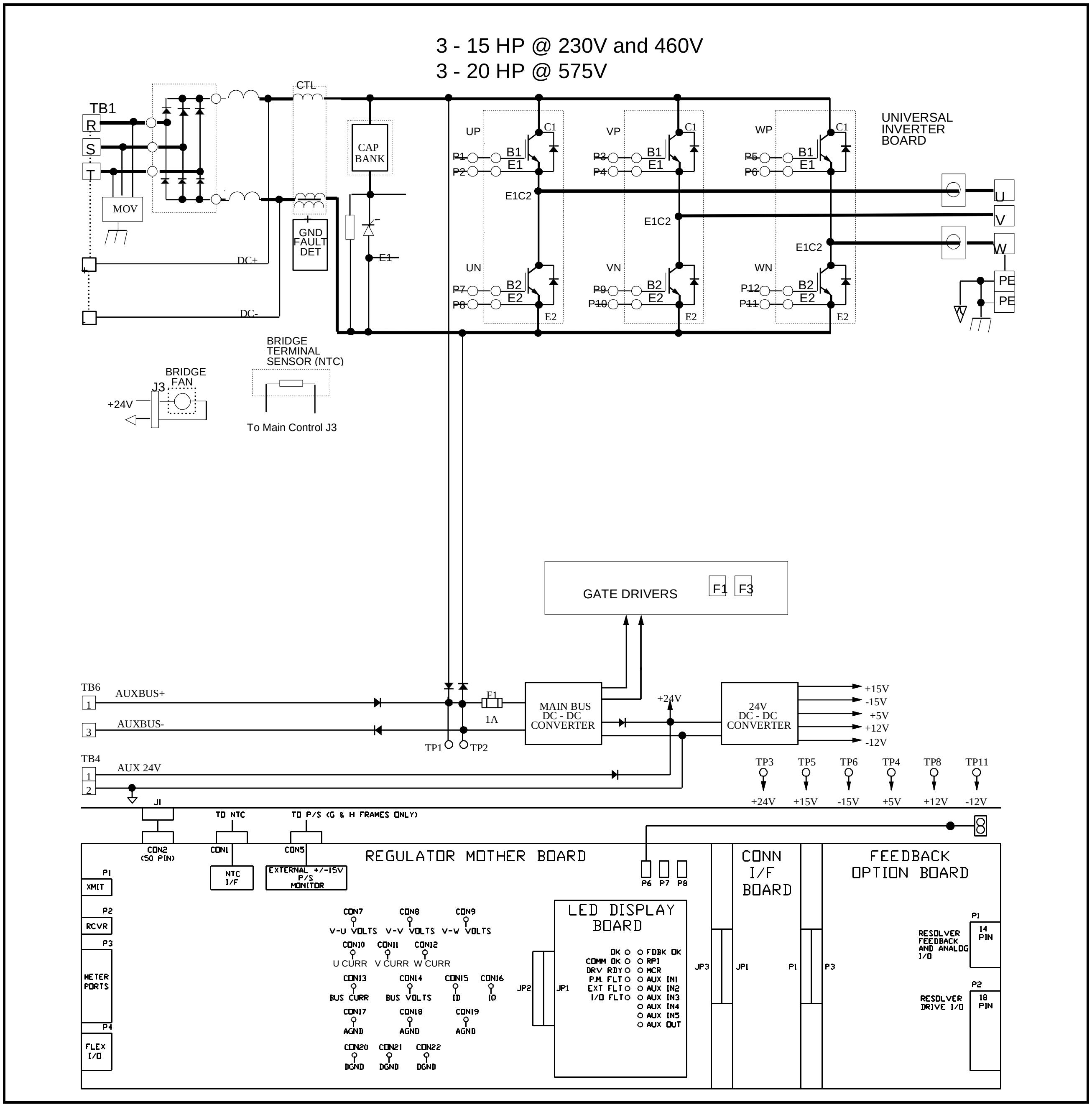


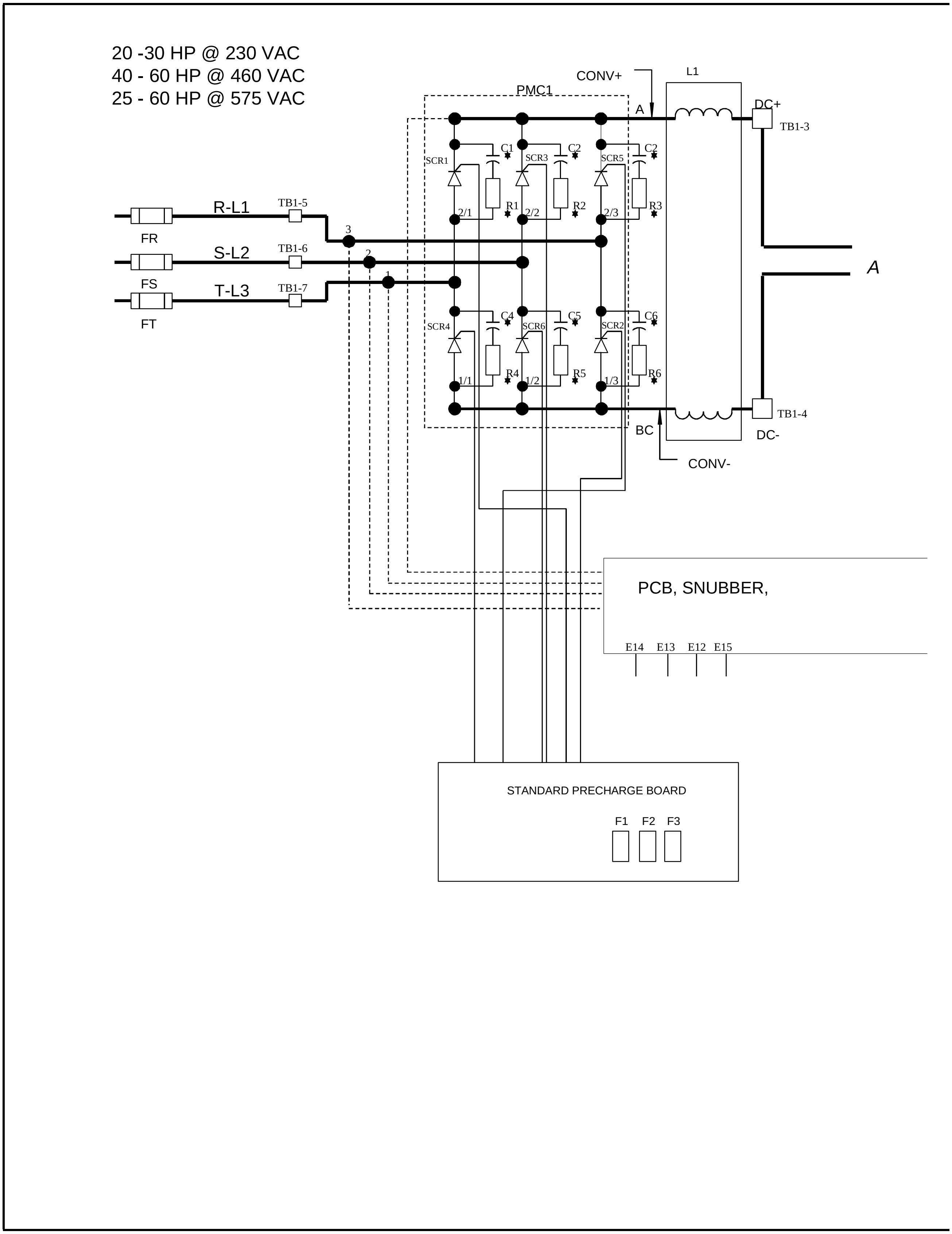
Figure A.30 – Derating for Input Voltage Exceeding Power Module Rating

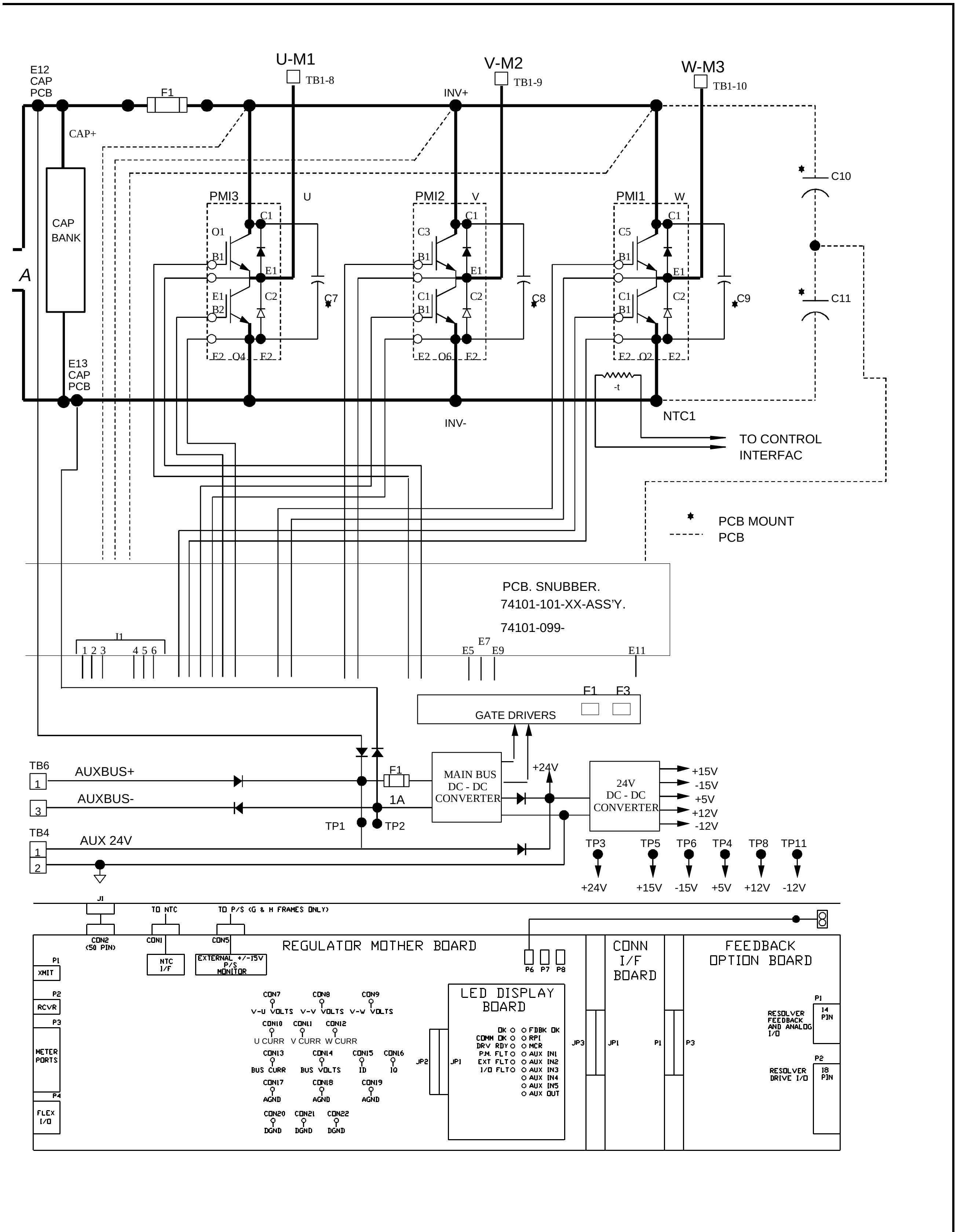
APPENDIX B

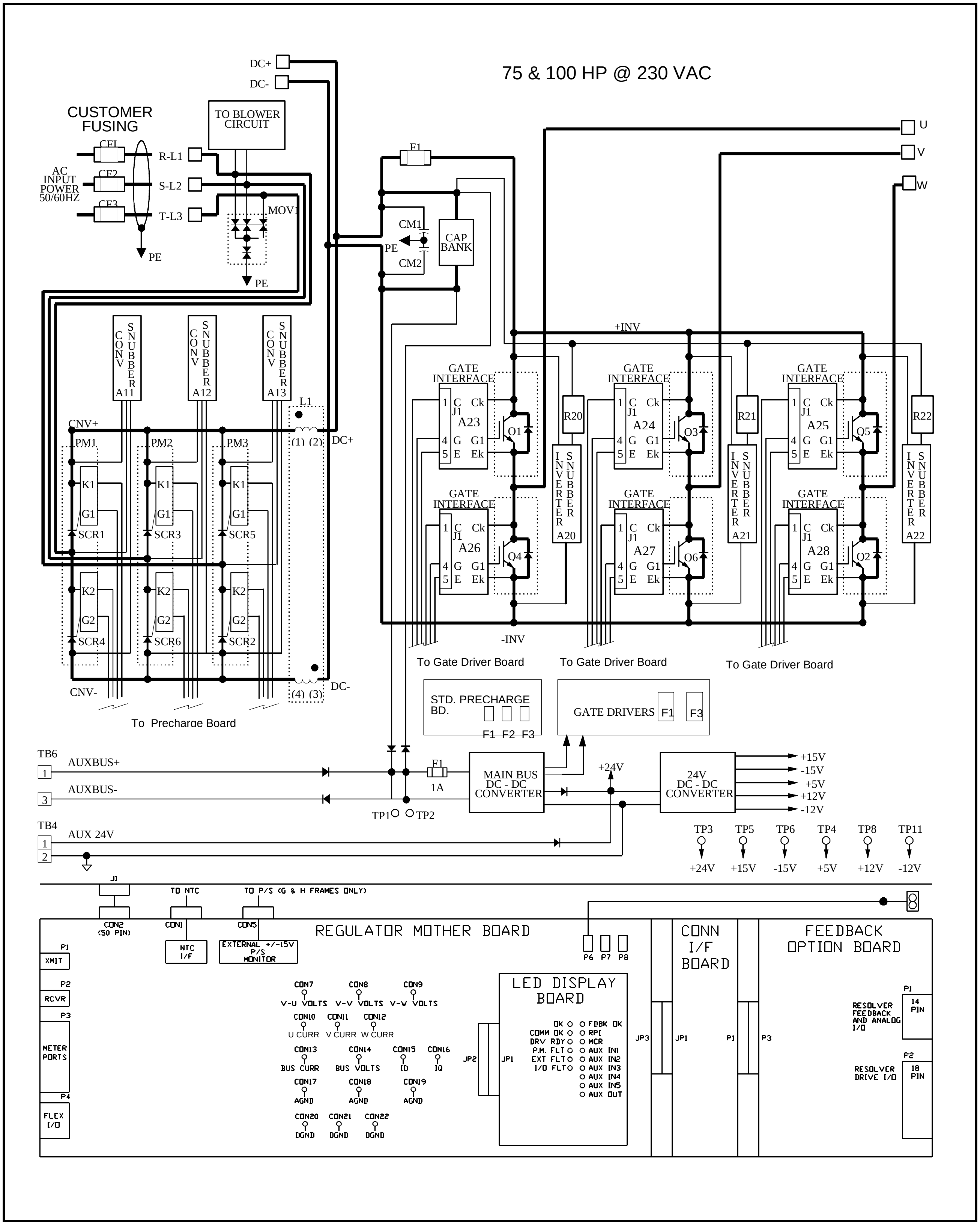
Schematic Diagrams

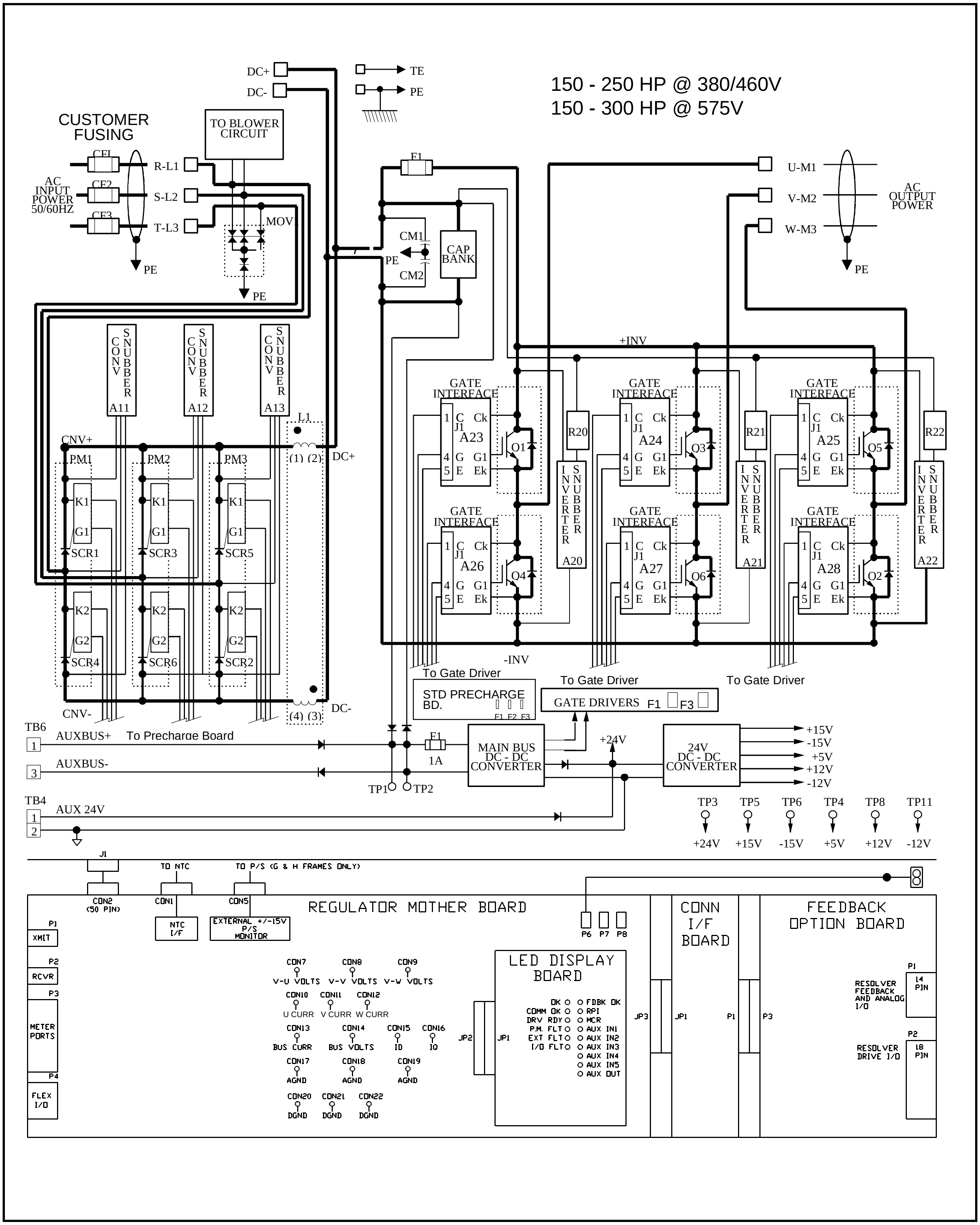
The following schematics illustrate the differences in hardware among various drive ratings. These are basic overviews of the SA3100 hardware that should be used as reference material only. See Appendix C for common bus input configurations.



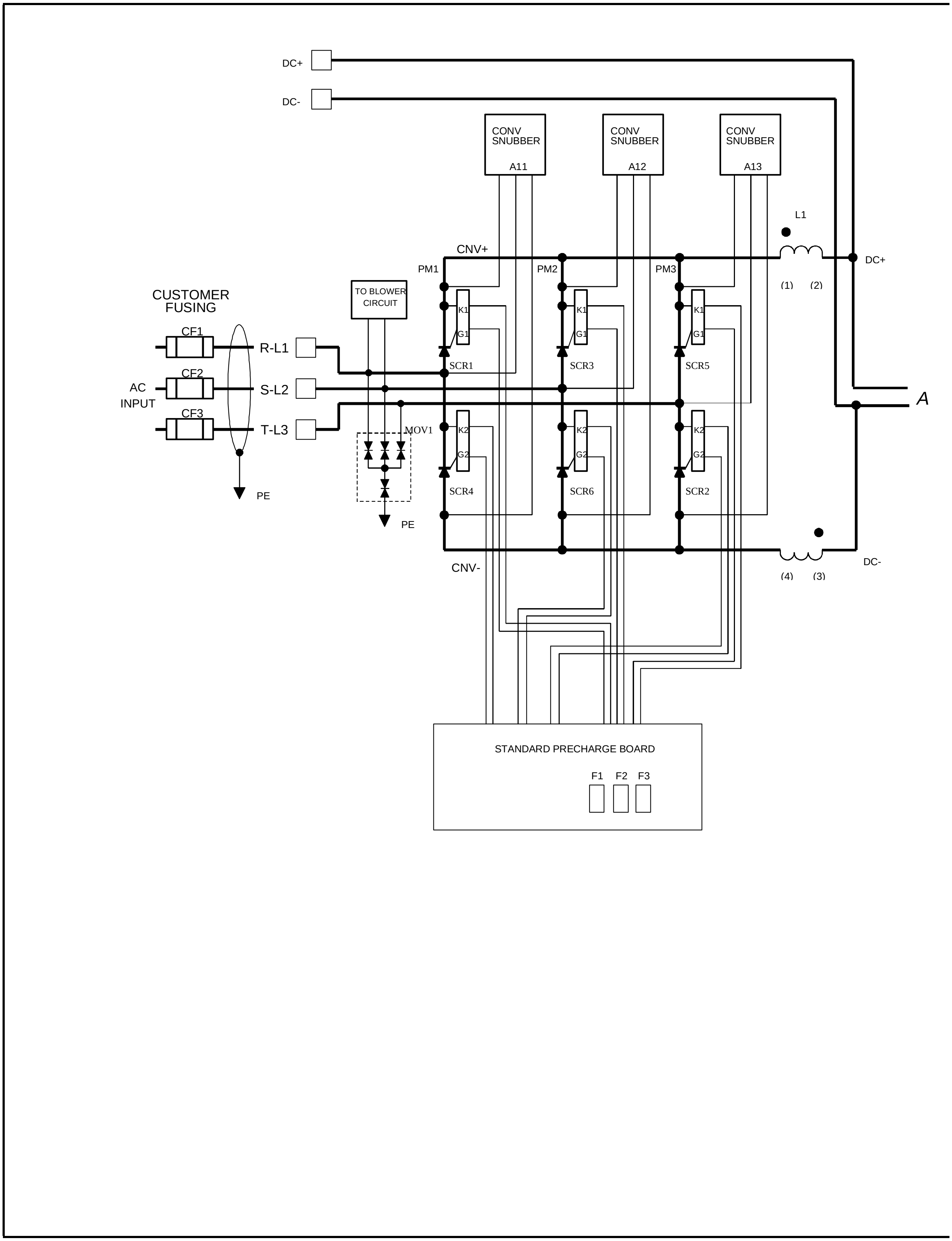

20 -30 HP @ 230 VAC
40 - 60 HP @ 460 VAC
25 - 60 HP @ 575 VAC
CONV+
L1
PMC1
A
DC+
TB1-3
SCR1
C1
SCR3
C2
SCR5
C2
R1
R2
R3
2/1
2/2
2/3
R-L1
TB1-5
FR
3
S-L2
TB1-6
2
FS
T-L3
TB1-7
1
FT
A
SCR4
C4
SCR6
C5
SCR2
C6
R4
R5
R6
1/1
1/2
1/3
TB1-4
BC
DC-
CONV-
PCB, SNUBBER,
E14
E13
E12
E15
STANDARD PRECHARGE BOARD
F1
F2
F3

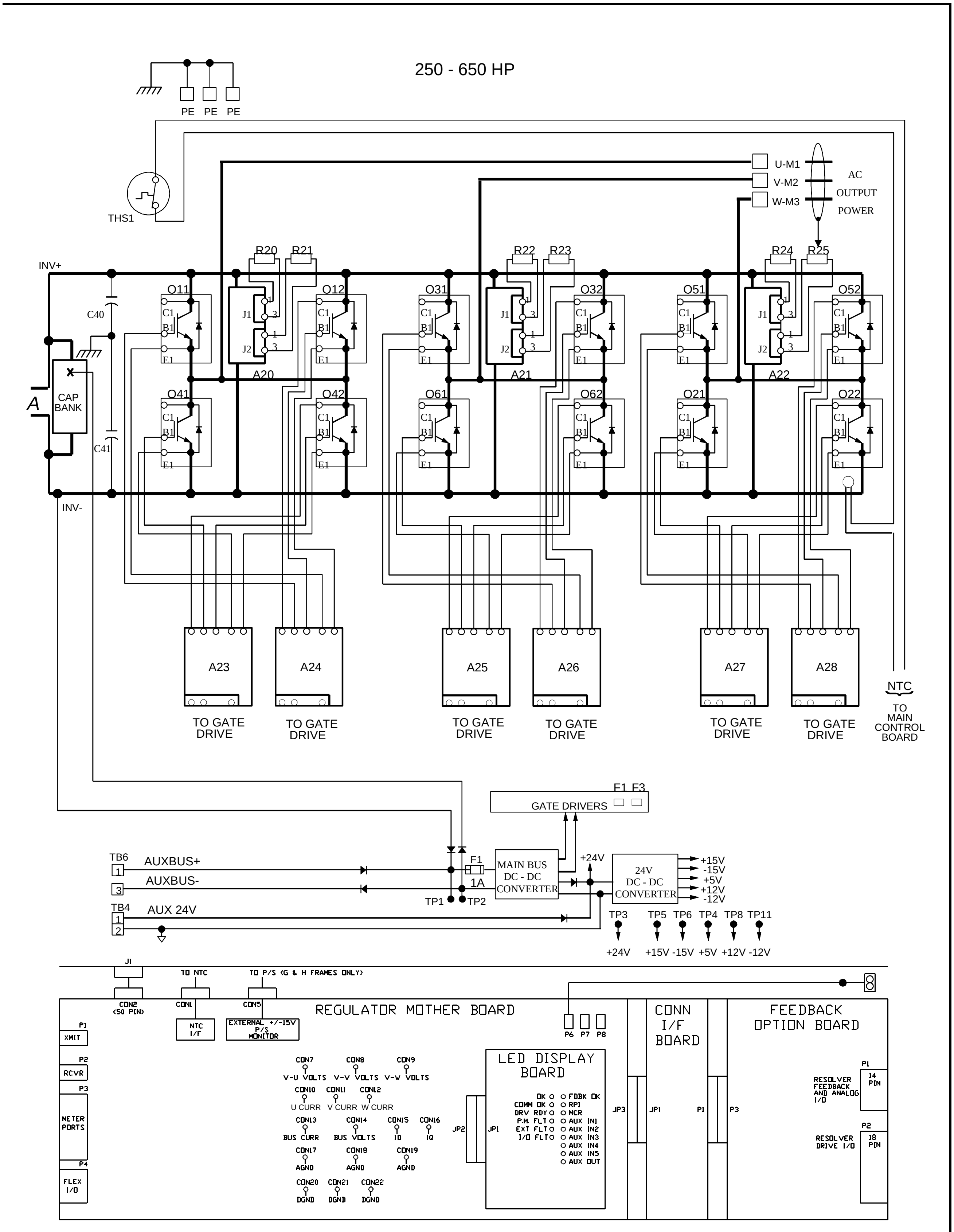

U-M1
TB1-8
V-M2
TB1-9
W-M3
TB1-10
E12
CAP
PCB
F1
INV+
CAP+
C10
PMI3
U
PMI2
V
PMI1
W
CAP
BANK
A
C7
C8
C9
C11
E13
CAP
PCB
INV-
NTC1
TO CONTROL
INTERFAC
PCB MOUNT
PCB
PCB. SNUBBER.
74101-101-XX-ASS'Y.
74101-099-
J1
E5
E7
E9
E11
F1
F3
GATE DRIVERS
TB6
AUXBUS+
AUXBUS-
F1
1A
MAIN BUS
DC - DC
CONVERTER
+24V
24V
DC - DC
CONVERTER
+15V
-15V
+5V
+12V
-12V
TP1
TP2
TB4
AUX 24V
TP3
TP5
TP6
TP4
TP8
TP11
+24V
+15V
-15V
+5V
+12V
-12V
TO NTC
TO P/S (G & H FRAMES ONLY)
CON2
(50 PIN)
CON1
CON5
REGULATOR MOTHER BOARD
NTC
I/F
EXTERNAL +/-15V
P/S
MONITOR
XMIT
RCVR
METER
PORTS
FLEX
I/O
CON7
CON8
CON9
V-U VOLTS
V-V VOLTS
V-W VOLTS
CON10
CON11
CON12
U CURR
V CURR
W CURR
CON13
CON14
CON15
CON16
BUS CURR
BUS VOLTS
ID
IQ
CON17
CON18
CON19
AGND
CON20
CON21
CON22
DGND
LED DISPLAY
BOARD
DK
COMM DK
DRV RDY
P.M. FLT
EXT FLT
I/O FLT
FDBK DK
RPI
MCR
AUX IN1
AUX IN2
AUX IN3
AUX IN4
AUX IN5
AUX OUT
P6 P7 P8
CONN
I/F
BOARD
FEEDBACK
OPTION BOARD
RESOLVER
FEEDBACK
AND ANALOG
I/O
14
PIN
RESOLVER
DRIVE I/O
18
PIN

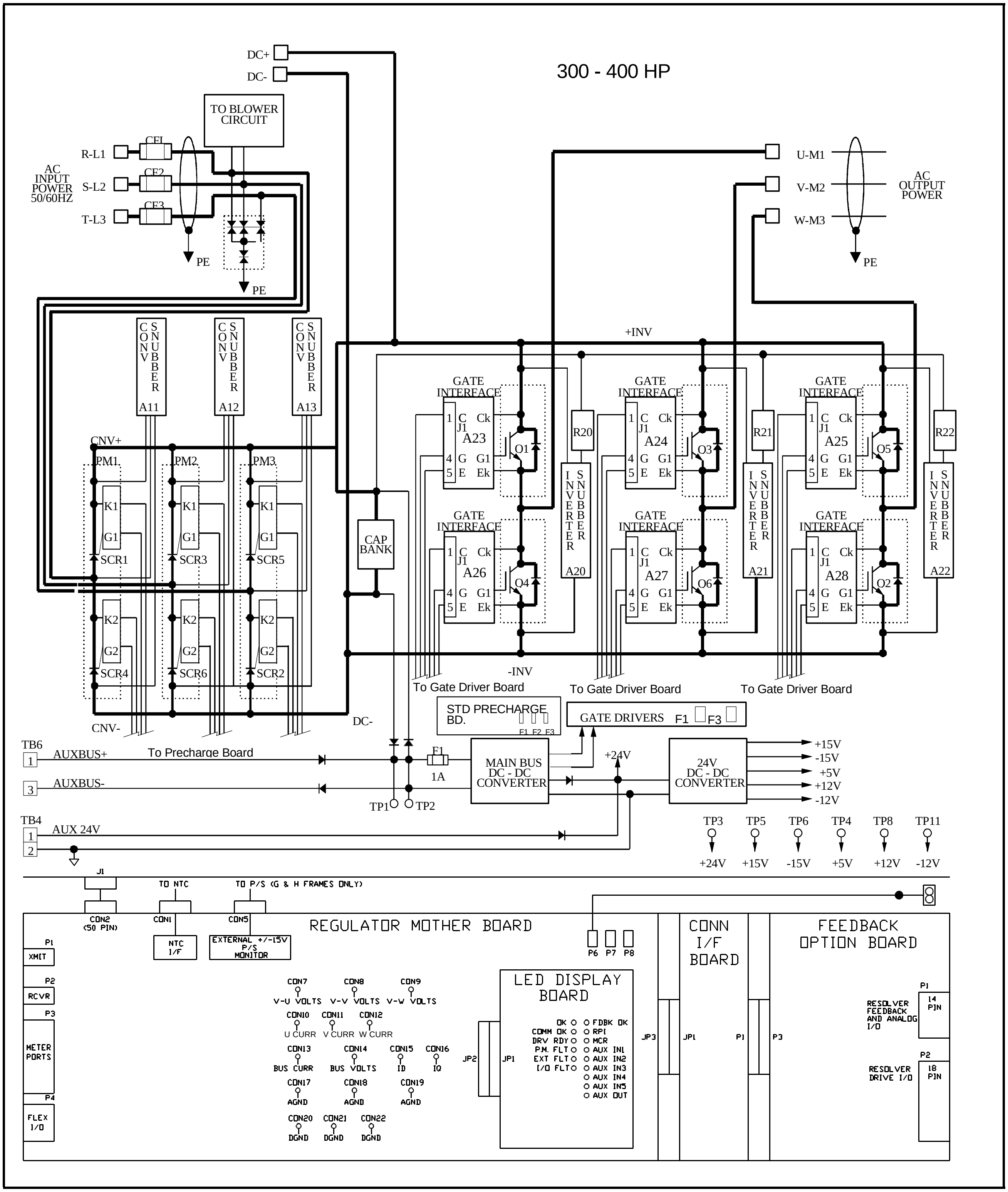

75 & 100 HP @ 230 VAC
CUSTOMER FUSING
AC INPUT POWER 50/60HZ
CF1
CF2
CF3
R-L1
S-L2
T-L3
PE
DC+
DC-
TO BLOWER CIRCUIT
MOV1
F1
CM1
CM2
CAP BANK
U
V
W
+INV
-INV
GATE INTERFACE
A23
A24
A25
A26
A27
A28
Q1
Q2
Q3
Q4
Q5
Q6
R20
R21
R22
INVERTER SNUBBER
A20
A21
A22
CONV SNUBBER
A11
A12
A13
L1
CNV+
CNV-
PM1
PM2
PM3
K1
K2
G1
G2
SCR1
SCR2
SCR3
SCR4
SCR5
SCR6
To Precharge Board
To Gate Driver Board
STD. PRECHARGE BD.
F1 F2 F3
GATE DRIVERS
TB6
AUXBUS+
AUXBUS-
TB4
AUX 24V
1A
TP1
TP2
MAIN BUS DC - DC CONVERTER
+24V
24V DC - DC CONVERTER
+15V
-15V
+5V
+12V
-12V
TP3
TP5
TP6
TP4
TP8
TP11
J1
TO NTC
TO P/S (G & H FRAMES ONLY)
CON2 (50 PIN)
CON1
CON5
REGULATOR MOTHER BOARD
XMIT
RCVR
METER PORTS
FLEX I/O
NTC I/F
EXTERNAL +/-15V P/S MONITOR
CON7 V-U VOLTS
CON8 V-V VOLTS
CON9 V-W VOLTS
CON10 U CURR
CON11 V CURR
CON12 W CURR
CON13 BUS CURR
CON14 BUS VOLTS
CON15 ID
CON16 IQ
CON17 AGND
CON18 AGND
CON19 AGND
CON20 DGND
CON21 DGND
CON22 DGND
LED DISPLAY BOARD
OK
COMM OK
DRV RDY
P.M. FLT
EXT FLT
I/O FLT
FDBK OK
RPI
MCR
AUX IN1
AUX IN2
AUX IN3
AUX IN4
AUX IN5
AUX OUT
P6 P7 P8
CONN I/F BOARD
FEEDBACK OPTION BOARD
RESOLVER FEEDBACK AND ANALOG I/O
14 PIN
RESOLVER DRIVE I/O
18 PIN



150 - 250 HP @ 380/460V
150 - 300 HP @ 575V
CUSTOMER FUSING
AC INPUT POWER 50/60HZ
R-L1
S-L2
T-L3
PE
TO BLOWER CIRCUIT
MOV
DC+
DC-
TE
CM1
CM2
CAP BANK
F1
U-M1
V-M2
W-M3
AC OUTPUT POWER
+INV
-INV
GATE INTERFACE
A23
A24
A25
A26
A27
A28
Q1
Q2
Q3
Q4
Q5
Q6
R20
R21
R22
INVERTER SNUBBER
A20
A21
A22
CONV SNUBBER
A11
A12
A13
L1
CNV+
CNV-
PM1
PM2
PM3
SCR1
SCR2
SCR3
SCR4
SCR5
SCR6
To Gate Driver
STD PRECHARGE BD.
GATE DRIVERS
TB6
AUXBUS+
To Precharge Board
AUXBUS-
1A
TP1
TP2
MAIN BUS DC - DC CONVERTER
+24V
24V DC - DC CONVERTER
+15V
-15V
+5V
+12V
-12V
TB4
AUX 24V
TP3
TP5
TP6
TP4
TP8
TP11
J1
TO NTC
TO P/S (G & H FRAMES ONLY)
CON2 (50 PIN)
CON1
CON5
NTC I/F
EXTERNAL +/-15V P/S MONITOR
REGULATOR MOTHER BOARD
XMIT
RCVR
METER PORTS
FLEX I/O
CON7
CON8
CON9
V-U VOLTS
V-V VOLTS
V-W VOLTS
CON10
CON11
CON12
U CURR
V CURR
W CURR
CON13
CON14
CON15
CON16
BUS CURR
BUS VOLTS
ID
IQ
CON17
CON18
CON19
AGND
CON20
CON21
CON22
DGND
LED DISPLAY BOARD
OK
COMM OK
DRV RDY
P.M. FLT
EXT FLT
I/O FLT
FDBK OK
RPI
MCR
AUX IN1
AUX IN2
AUX IN3
AUX IN4
AUX IN5
AUX OUT
P6
P7
P8
JP1
JP2
JP3
CONN I/F BOARD
FEEDBACK OPTION BOARD
RESOLVER FEEDBACK AND ANALOG I/O
14 PIN
RESOLVER DRIVE I/O
18 PIN


DC+
DC-
CONV SNUBBER A11
CONV SNUBBER A12
CONV SNUBBER A13
L1
CNV+
PM1
PM2
PM3
DC+
(1) (2)
CUSTOMER FUSING
TO BLOWER CIRCUIT
CF1
CF2
CF3
R-L1
S-L2
T-L3
AC INPUT
K1
G1
SCR1
SCR3
SCR5
A
MOV1
K2
G2
SCR4
SCR6
SCR2
PE
PE
CNV-
DC-
(4) (3)
STANDARD PRECHARGE BOARD
F1 F2 F3

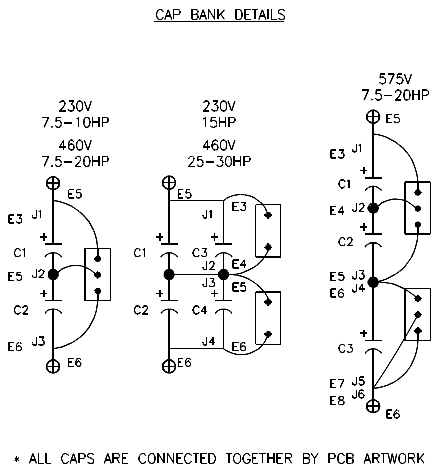

250 - 650 HP
PE PE PE
THS1
U-M1
V-M2
W-M3
AC
OUTPUT
POWER
INV+
INV-
C40
C41
CAP
BANK
A
R20 R21
R22 R23
R24 R25
O11 O12 O31 O32 O51 O52
O41 O42 O61 O62 O21 O22
A20 A21 A22
J1 J2
C1 B1 E1
A23 A24 A25 A26 A27 A28
TO GATE
DRIVE
NTC
TO
MAIN
CONTROL
BOARD
F1 F3
GATE DRIVERS
TB6
AUXBUS+
AUXBUS-
TB4
AUX 24V
F1
1A
TP1 TP2
MAIN BUS
DC - DC
CONVERTER
+24V
24V
DC - DC
CONVERTER
+15V
-15V
+5V
+12V
-12V
TP3 TP5 TP6 TP4 TP8 TP11
+24V +15V -15V +5V +12V -12V
J1
TO NTC
TO P/S (G & H FRAMES ONLY)
CON2
(50 PIN)
CON1
CON5
REGULATOR MOTHER BOARD
NTC
I/F
EXTERNAL +/-15V
P/S
MONITOR
P1
XMIT
P2
RCVR
P3
METER
PORTS
P4
FLEX
I/O
CON7 CON8 CON9
V-U VOLTS V-V VOLTS V-W VOLTS
CON10 CON11 CON12
U CURR V CURR W CURR
CON13 CON14 CON15 CON16
BUS CURR BUS VOLTS ID IQ
CON17 CON18 CON19
AGND AGND AGND
CON20 CON21 CON22
DGND DGND DGND
P6 P7 P8
LED DISPLAY
BOARD
JP2 JP1
OK
COMM OK
DRV RDY
P.M. FLT
EXT FLT
I/O FLT
FDBK OK
RPI
MCR
AUX IN1
AUX IN2
AUX IN3
AUX IN4
AUX IN5
AUX OUT
CONN
I/F
BOARD
JP3 JP1 P1 P3
FEEDBACK
OPTION BOARD
RESOLVER
FEEDBACK
AND ANALOG
I/O
P1
14
PIN
RESOLVER
DRIVE I/O
P2
18
PIN


300 - 400 HP
DC+
DC-
TO BLOWER CIRCUIT
AC INPUT POWER 50/60HZ
R-L1
S-L2
T-L3
CF1
CF2
CF3
PE
U-M1
V-M2
W-M3
AC OUTPUT POWER
+INV
-INV
CNV+
CNV-
PM1
PM2
PM3
SCR1
SCR3
SCR5
SCR4
SCR6
SCR2
A11
A12
A13
CAP BANK
GATE INTERFACE
A23
A24
A25
A26
A27
A28
R20
R21
R22
A20
A21
A22
To Gate Driver Board
STD PRECHARGE BD.
GATE DRIVERS
TB6
AUXBUS+
AUXBUS-
To Precharge Board
F1
1A
TP1
TP2
MAIN BUS DC - DC CONVERTER
+24V
24V DC - DC CONVERTER
+15V
-15V
+5V
+12V
-12V
TB4
AUX 24V
TP3
TP5
TP6
TP4
TP8
TP11
+24V
+15V
-15V
+5V
+12V
-12V
TO NTC
TO P/S (G & H FRAMES ONLY)
REGULATOR MOTHER BOARD
CON2 (50 PIN)
CON1
CON5
NTC I/F
EXTERNAL +/-15V P/S MONITOR
XMIT
RCVR
METER PORTS
FLEX I/O
CON7 V-U VOLTS
CON8 V-V VOLTS
CON9 V-W VOLTS
CON10 U CURR
CON11 V CURR
CON12 W CURR
CON13 BUS CURR
CON14 BUS VOLTS
CON15 ID
CON16 IQ
CON17 AGND
CON18 AGND
CON19 AGND
CON20 DGND
CON21 DGND
CON22 DGND
LED DISPLAY BOARD
OK
COMM OK
DRV RDY
P.M. FLT
EXT FLT
I/O FLT
FDBK OK
RPI
MCR
AUX IN1
AUX IN2
AUX IN3
AUX IN4
AUX IN5
AUX OUT
P6 P7 P8
CONN I/F BOARD
FEEDBACK OPTION BOARD
RESOLVER FEEDBACK AND ANALOG I/O
14 PIN
RESOLVER DRIVE I/O
18 PIN

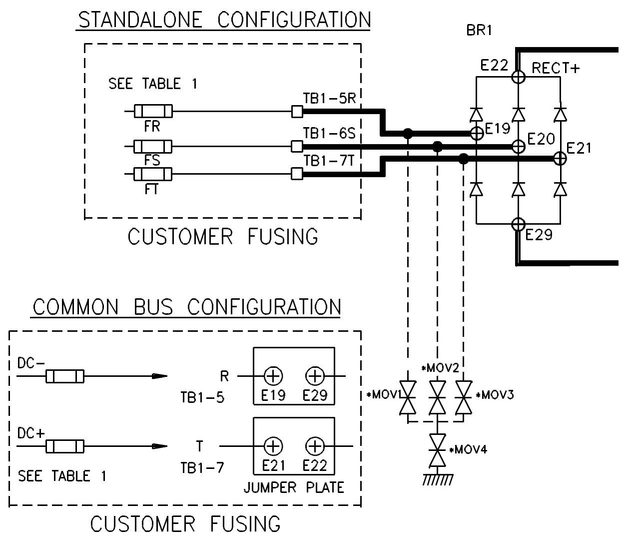
APPENDIX C

Inverter Configurations for Common Bus Applications

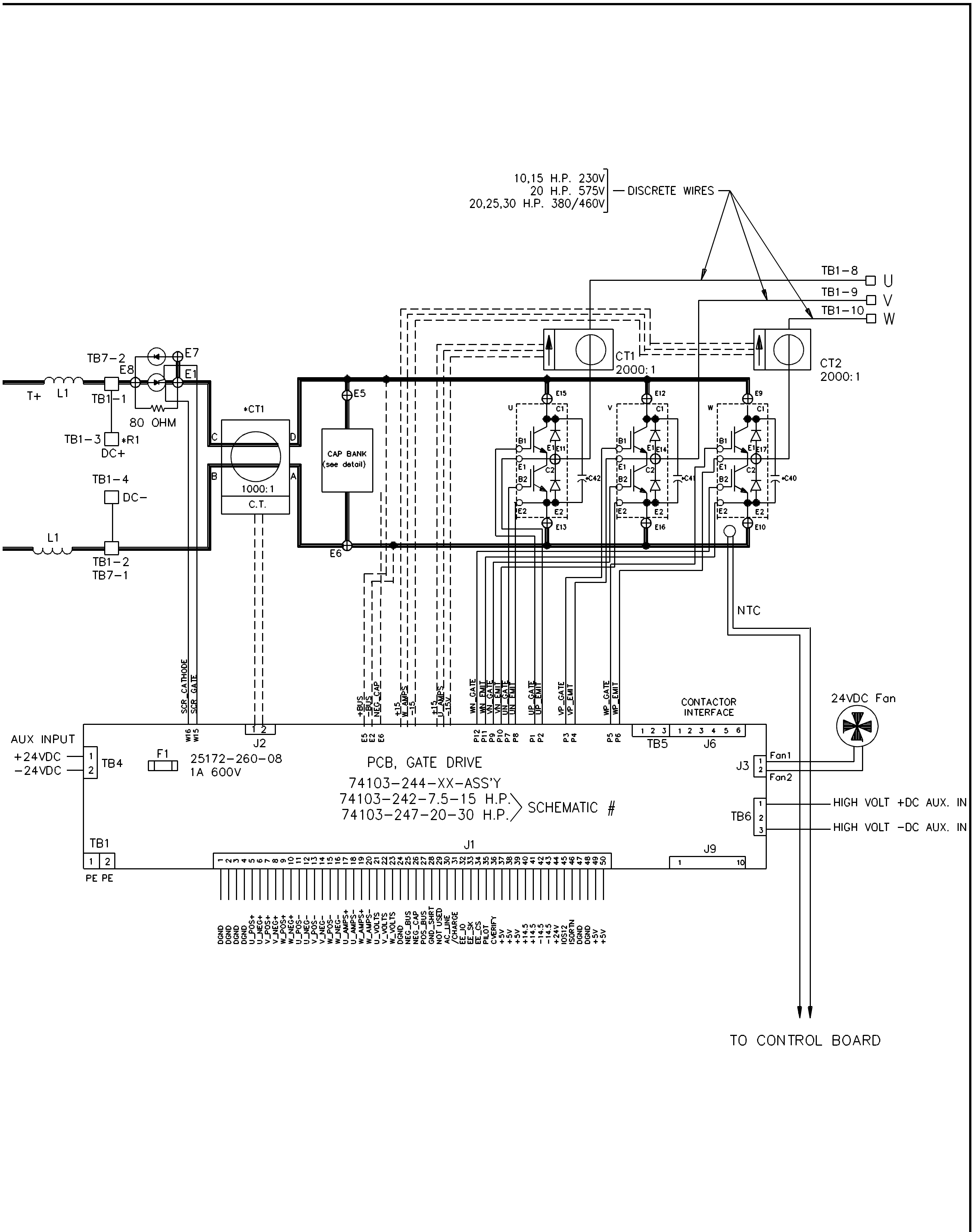
The figures in this appendix show the inverter configurations of the various SA3100 Power Modules for common bus applications. These figures provide basic overviews of the SA3100 hardware and are to be used as reference material only. Refer to the wiring diagrams (W/Ds), prints, and other documentation supplied with your drive for specific information about your SA3100 common bus drive system.



7.5 - 15 HP @ 230 VAC / 330 VDC
7.5 - 30 HP @ 460 VAC / 650 VDC
7.5 - 20 HP @ 575 VAC / 820 VDC

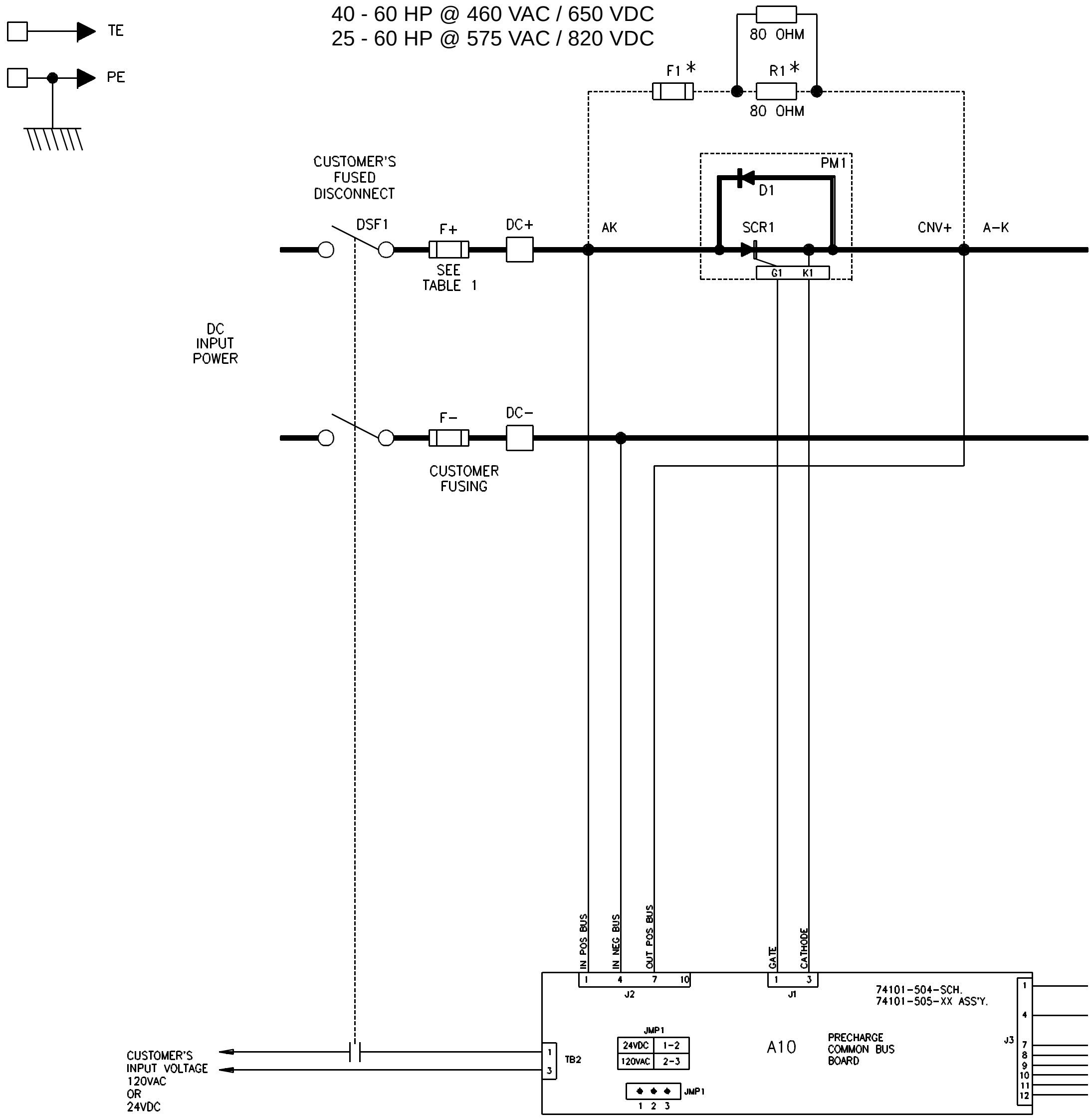


HP	VOLTAGE	STAND-ALONE FUSE (AC) FR,FS,FT TYPE JJ	COMMON BUS FUSE (DC) SPP,FWP,A70Q
7.5	230	35	35
10	230	45	50
15	230	70	60
7.5CT 10VT	380/460	20	20
10CT 15VT	380/460	30	25
15CT 20VT	380/460	35	35
20CT 25VT	380/460	45	50
25CT 30VT	380/460	60	60
30CT 30IEC	380/460	70	60
7.5	575	15	15
10	575	20	20
15	575	25	30
20	575	35	35



10,15 H.P. 230V
20 H.P. 575V
20,25,30 H.P. 380/460V
DISCRETE WIRES
TB1-8 U
TB1-9 V
TB1-10 W
CT1 2000:1
CT2 2000:1
TB7-2
E8
E7
E1
T+
L1
TB1-1
80 OHM
TB1-3
R1
DC+
TB1-4
DC-
TB1-2
TB7-1
CT1
1000:1
C.T.
CAP BANK (see detail)
E5
E6
NTC
SCR_CATHODE
SCR_GATE
AUX INPUT
+24VDC
-24VDC
TB4
F1
25172-260-08
1A 600V
J2
PCB, GATE DRIVE
74103-244-XX-ASS'Y
74103-242-7.5-15 H.P.
74103-247-20-30 H.P.
SCHEMATIC #
CONTACTOR INTERFACE
TB5
J6
24VDC Fan
Fan1
Fan2
J3
TB6
HIGH VOLT +DC AUX. IN
HIGH VOLT -DC AUX. IN
TB1
PE PE
J1
J9
TO CONTROL BOARD

20 - 30 HP @ 230 VAC / 330 VDC
40 - 60 HP @ 460 VAC / 650 VDC
25 - 60 HP @ 575 VAC / 820 VDC



CAP BANK DETAILS

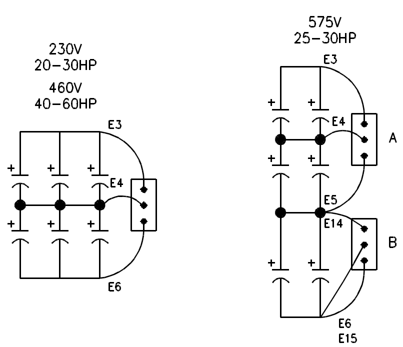
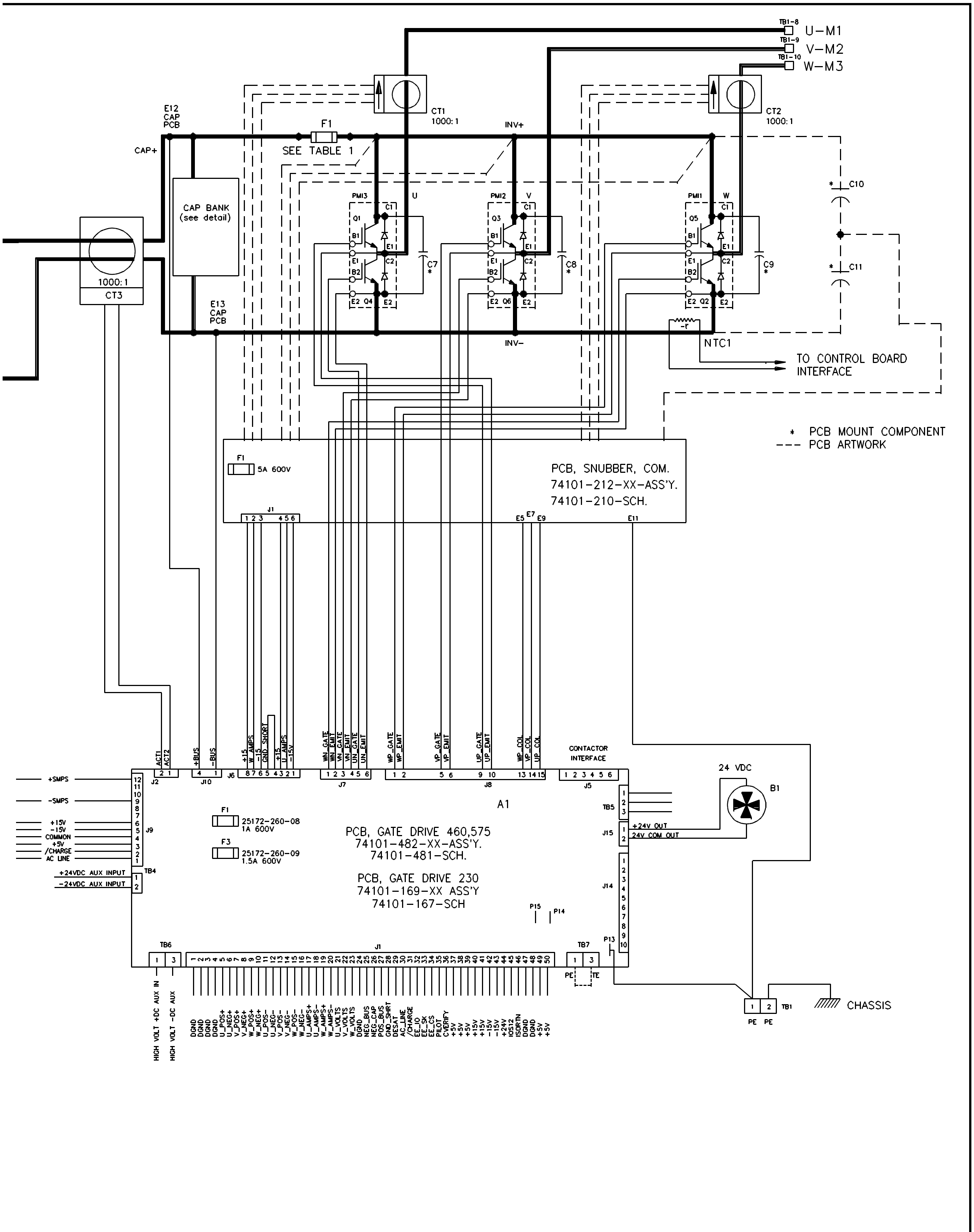


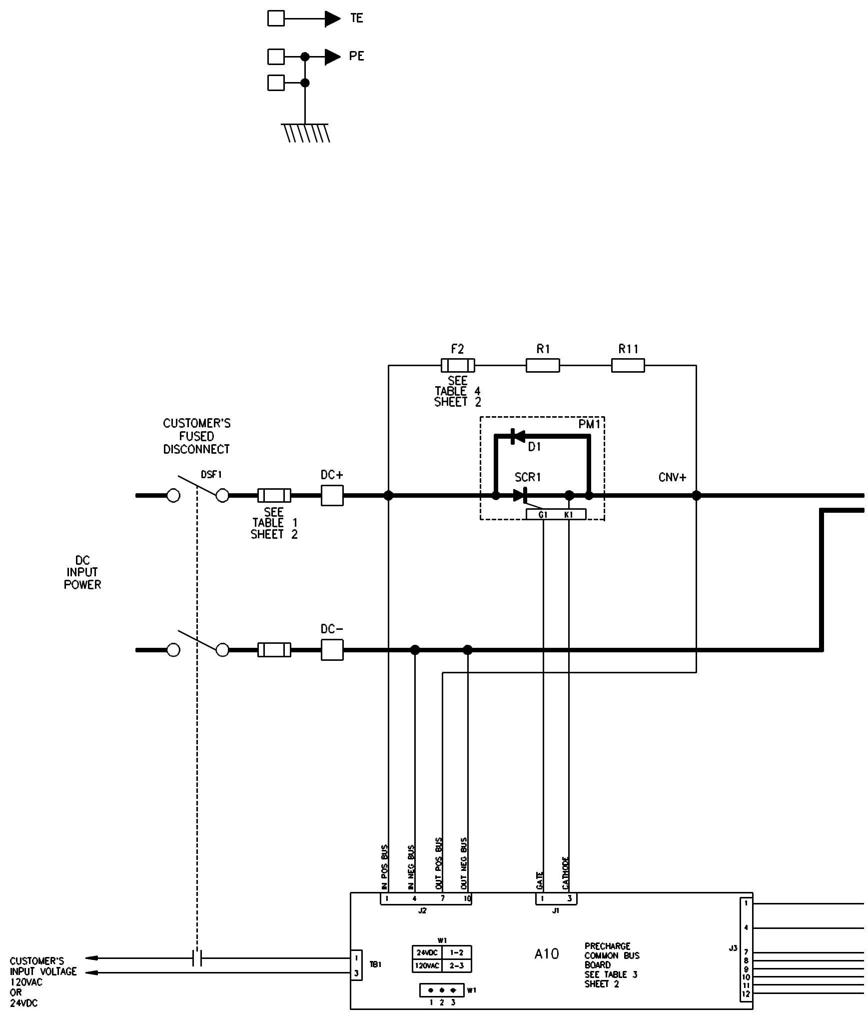
TABLE 1

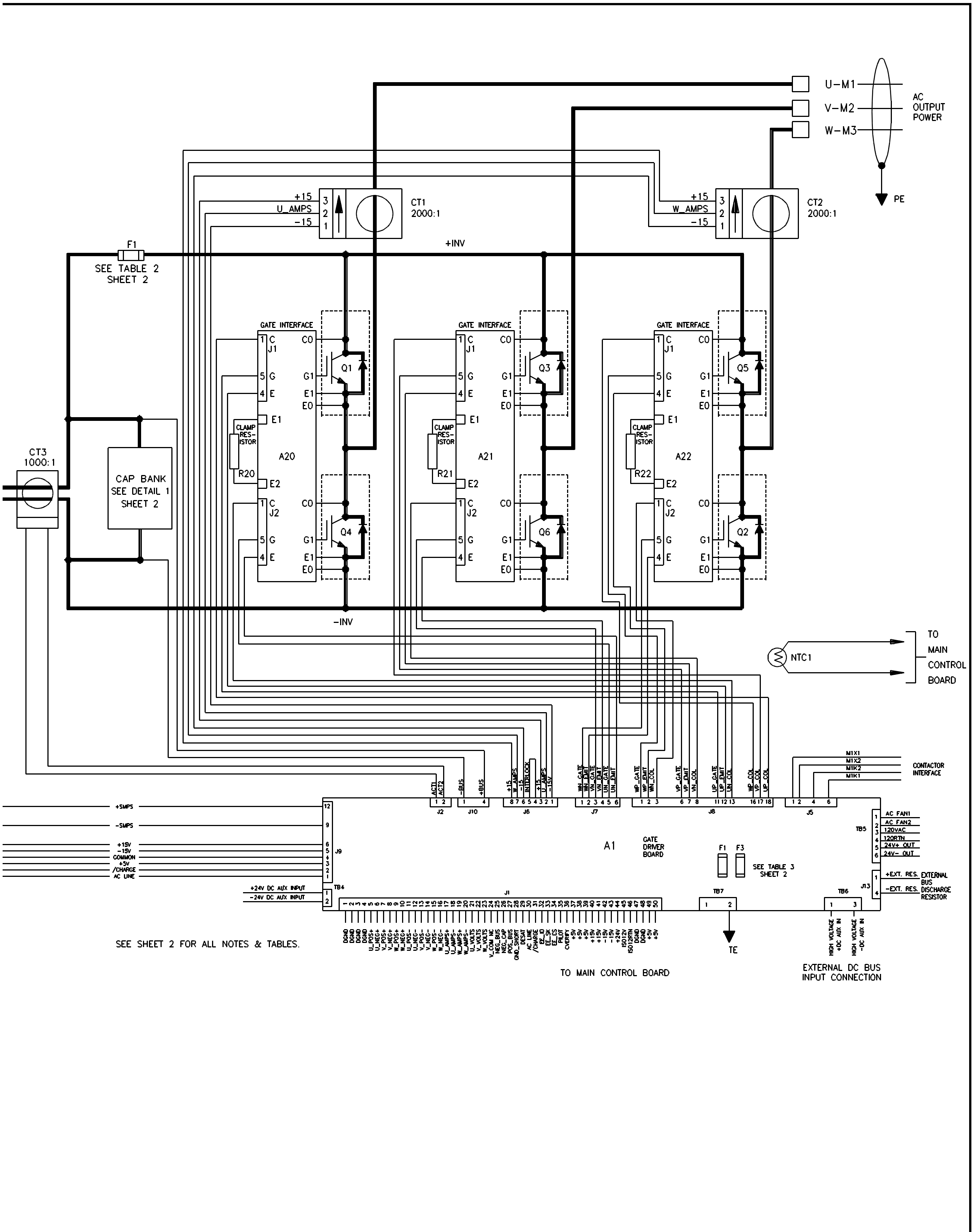
	DC FUSE INVERTER F1	LINE FUSE (DC) F+ F-
HP RATING	A70Q TYPE	
230VAC		
20	100A,700V	100A
25	125A,700V	100A
30	125A,700V	125A
380/460VAC		
40CT 50VT	100A,700V	100A
50CT 60VT	125A,700V	125A
60 460V ONLY	125A,700V	125A
575VAC		
25	50A,700V	50A
30	60A,700V	60A
40	70A,700V	70A
50	90A,700V	90A
60	100A,700V	100A



U-M1
V-M2
W-M3
CT1 1000:1
CT2 1000:1
CT3 1000:1
F1
SEE TABLE 1
CAP BANK (see detail)
E12 CAP PCB
E13 CAP PCB
CAP+
INV+
INV-
C7
C8
C9
C10
C11
NTC1
TO CONTROL BOARD INTERFACE
* PCB MOUNT COMPONENT
--- PCB ARTWORK
PCB, SNUBBER, COM.
74101-212-XX-ASS'Y.
74101-210-SCH.
5A 600V
A1
PCB, GATE DRIVE 460,575
74101-482-XX-ASS'Y.
74101-481-SCH.
PCB, GATE DRIVE 230
74101-169-XX ASS'Y
74101-167-SCH
25172-260-08 1A 600V
25172-260-09 1.5A 600V
CONTACTOR INTERFACE
24 VDC
B1
+24V OUT
24V COM OUT
+24VDC AUX INPUT
-24VDC AUX INPUT
HIGH VOLT +DC AUX IN
HIGH VOLT -DC AUX
CHASSIS

40 - 60 HP @ 230 VAC / 330 VDC
60 - 150 HP @ 460 VAC / 650 VDC
75 - 125 HP @ 575 VAC / 820 VDC





SEE SHEET 2 FOR ALL NOTES & TABLES.

40 - 60 HP @ 230 VAC / 330 VDC
60 - 150 HP @ 460 VAC / 650 VDC
75 - 125 HP @ 575 VAC / 820 VDC

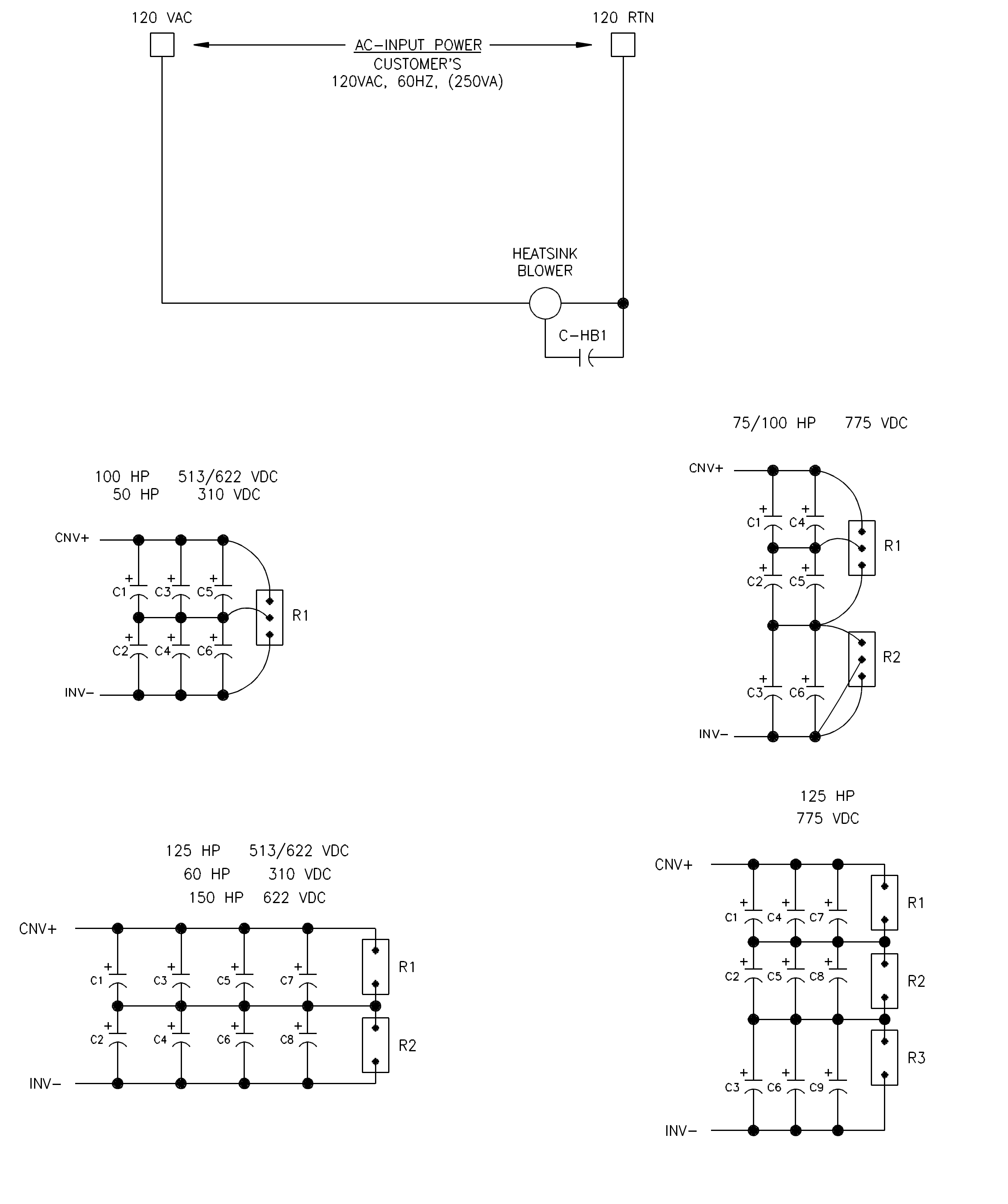


TABLE 1: CUSTOMER FUSING
BASED ON MAXIMUM DRIVE RATING THE FOLLOWING FUSES OR APPROVED EQUIVALENT MUST BE USED:

HORSEPOWER	310VDC FUSE CURRENT/TYPE	513/622VDC FUSE CURRENT/TYPE	775VDC FUSE CURRENT/TYPE
40	175 AMP, CLASS T, JJS	–	–
50	225 AMP, CLASS T, JJS	–	–
60	250 AMP, CLASS T, JJS	150 AMP, CLASS T, JJS	–
75	–	175 AMP, CLASS T, JJS	125 AMP, CLASS T, JJS
100	–	225 AMP, CLASS T, JJS	175 AMP, CLASS T, JJS
125	–	250 AMP, CLASS T, JJS	200 AMP, CLASS T, JJS
150	–	250 AMP, CLASS T, JJS	

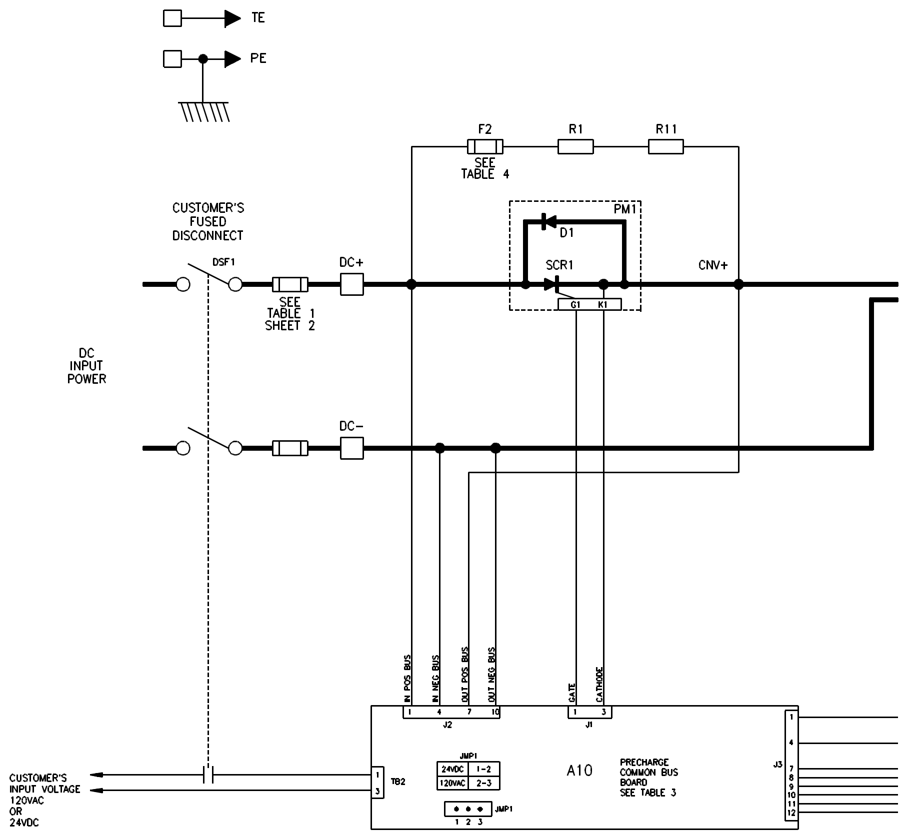
TABLE 2: BASED ON DRIVE HORSEPOWER, THE INVERTER DC + BUS FUSE WILL CHANGE AMP RATING. THE TABLE BELOW DEFINES THE FUSE RATING.

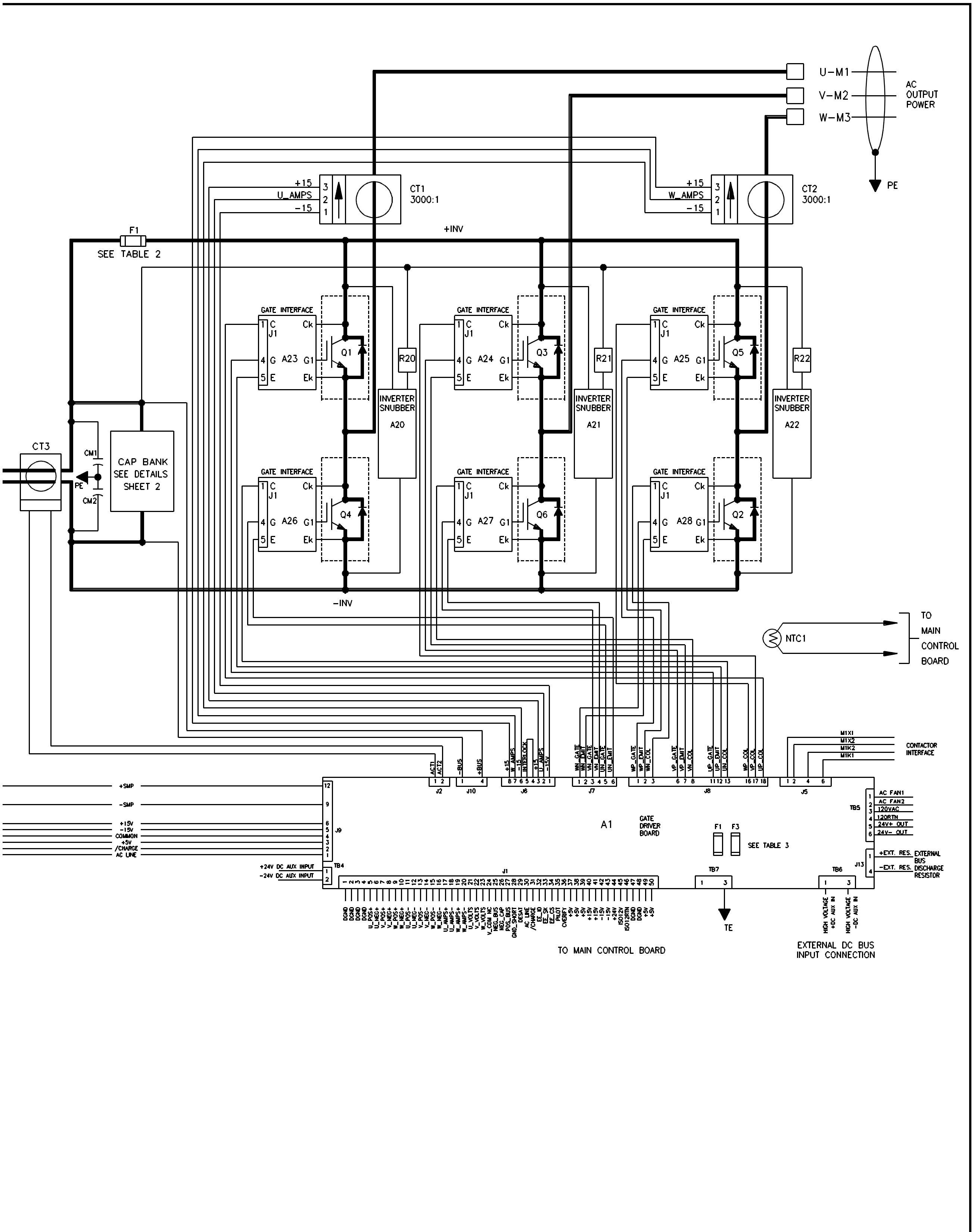
DRIVE HORSEPOWER, INPUT VOLTAGE	FUSE INFORMATION		
	RATING	TYPE	P/N
40HP, 310VDC	150 AMP	A70Q150–4	25178–310–10
50HP, 310VDC	200 AMP	A70Q200–4	25178–310–12
60HP, 310VDC	250 AMP	A70Q250–4	25178–310–13
60HP, 513VDC/622VAC	125 AMP	A70Q125–4	25178–310–09
75HP, 513/622VDC	150 AMP	A70Q150–4	25178–310–10
75HP, 775VDC	125 AMP	A70Q125–4	25178–310–09
100HP, 513/622VDC	200 AMP	A70Q200–4	25178–310–12
100HP, 775VDC	175 AMP	A70Q175–4	25178–310–11
125HP, 513/622VDC	250 AMP	A70Q250–4	25178–310–13
125HP, 775VDC	200 AMP	A70Q200–4	25178–310–12
150HP, 622VDC	250 AMP	A70Q250–4	25178–310–13

TABLE 3: BASED ON DRIVE HORSEPOWER, THE PRECHARGE FUSE, F2 FUSE WILL CHANGE AMP RATING. THE TABLE BELOW DEFINES THE FUSE RATING.

DRIVE HORSEPOWER, INPUT DC VOLTAGE	FUSE INFORMATION		
	RATING	TYPE	P/N
40,50,60 HP – 310VDC 60,75,100,125HP–513/622VDC 150 HP – 622VDC 75, 100 HP – 775VDC	10	A70P	25178–306–03
125 HP – 775VDC	15	A70P	25178–306–04

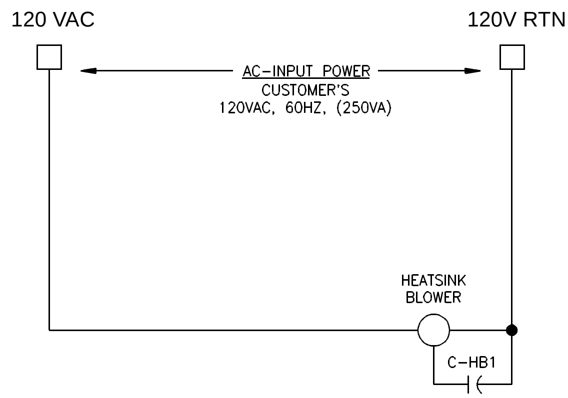
150 - 250 HP @ 460 VAC / 650 VDC
150 - 300 HP @ 575 VAC / 820 VDC

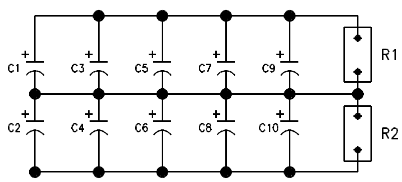




U-M1
V-M2
W-M3
AC OUTPUT POWER
PE
CT1 3000:1
CT2 3000:1
+15
U_AMPS
-15
W_AMPS
F1
SEE TABLE 2
+INV
-INV
GATE INTERFACE
A23
A24
A25
A26
A27
A28
Q1
Q2
Q3
Q4
Q5
Q6
R20
R21
R22
INVERTER SNUBBER
A20
A21
A22
CT3
CM1
CM2
CAP BANK SEE DETAILS SHEET 2
NTC1
TO MAIN CONTROL BOARD
CONTACTOR INTERFACE
A1
GATE DRIVER BOARD
F1 F3
SEE TABLE 3
+SMP
-SMP
+15V
-15V
COMMON
+5V
/CHARGE
AC LINE
+24V DC AUX INPUT
-24V DC AUX INPUT
AC FAN1
AC FAN2
120VAC
120RTN
24V+ OUT
24V- OUT
+EXT. RES.
-EXT. RES.
EXTERNAL BUS DISCHARGE RESISTOR
TE
TO MAIN CONTROL BOARD
EXTERNAL DC BUS INPUT CONNECTION

150 - 250 HP @ 460 VAC / 650 VDC
150 - 300 HP @ 575 VAC / 820 VDC

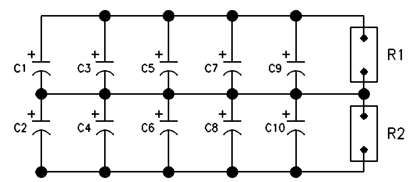




DETAIL 1 – 513/622 VDC

NOTES: – DETAIL 1:

1. C1 THRU C10 ARE 400 VDC CAPACITORS.
2. FOR 150HP C5 AND C6 ARE NOT SUPPLIED.



DETAIL 2 – 775 VDC

NOTES: – DETAIL 2:

1. C1 THRU C10 ARE 500 VDC CAPACITORS.
2. FOR 150 HP C3, C4, C7, C8 ARE NOT SUPPLIED.
3. FOR 200 HP C5 AND C6 ARE NOT SUPPLIED.

TABLE 1: CUSTOMER FUSING
BASED ON MAXIMUM DRIVE RATING THE FOLLOWING FUSES OR APPROVED EQUIVALENT MUST BE USED:

HORSEPOWER	513/622VDC FUSE CURRENT/TYPE	775VDC FUSE CURRENT/TYPE
150	500A SPP	350A SPP
200	500A SPP	500A SPP
250	500A SPP	500A SPP
300	N/A	700A SPP

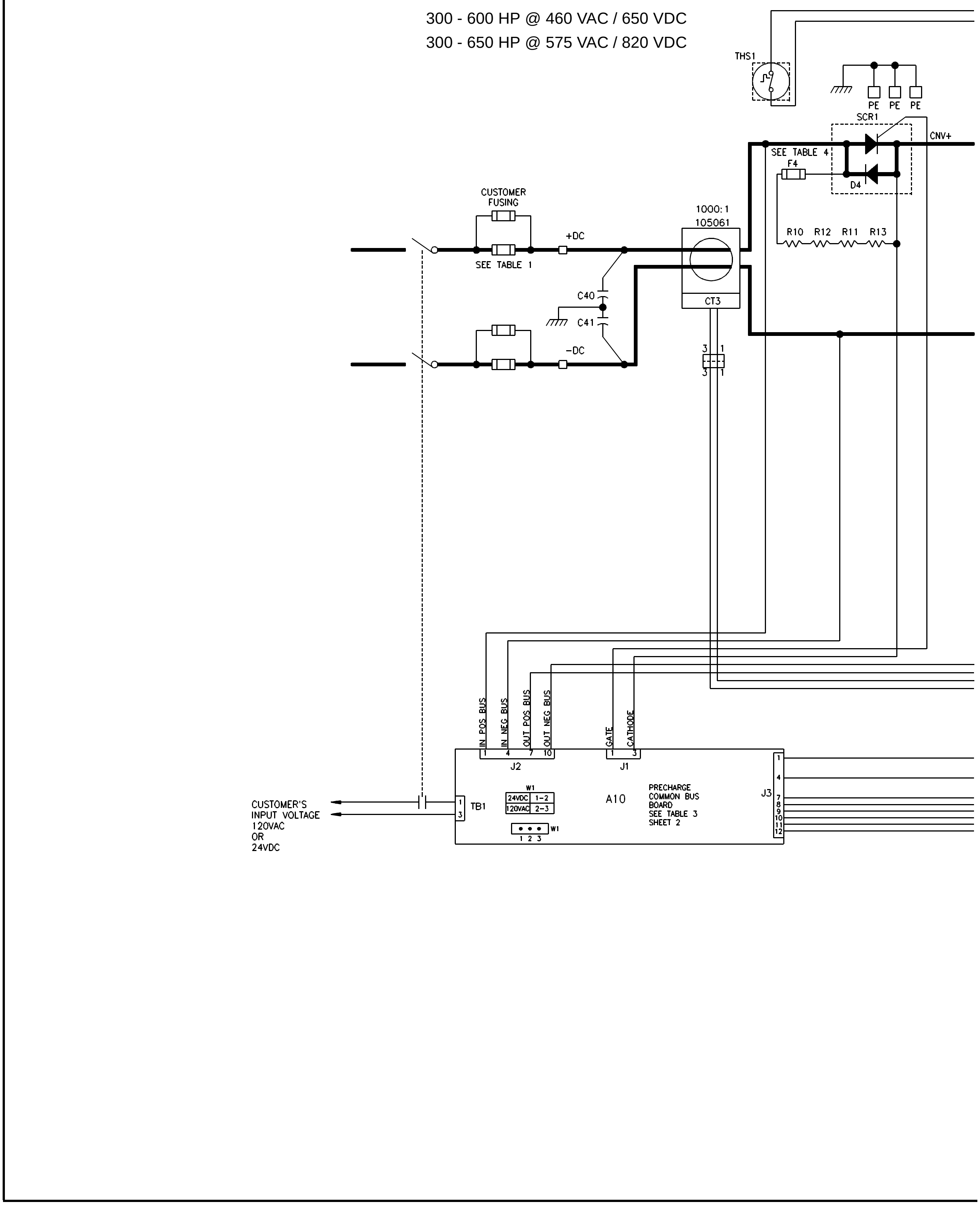
TABLE 2: THE INVERTER DC + BUS FUSE WILL REMAIN ONE AMP RATING. FOR ALL UNITES IN THIS FRAME, THE TABLE BELOW DEFINES THE FUSE RATING.

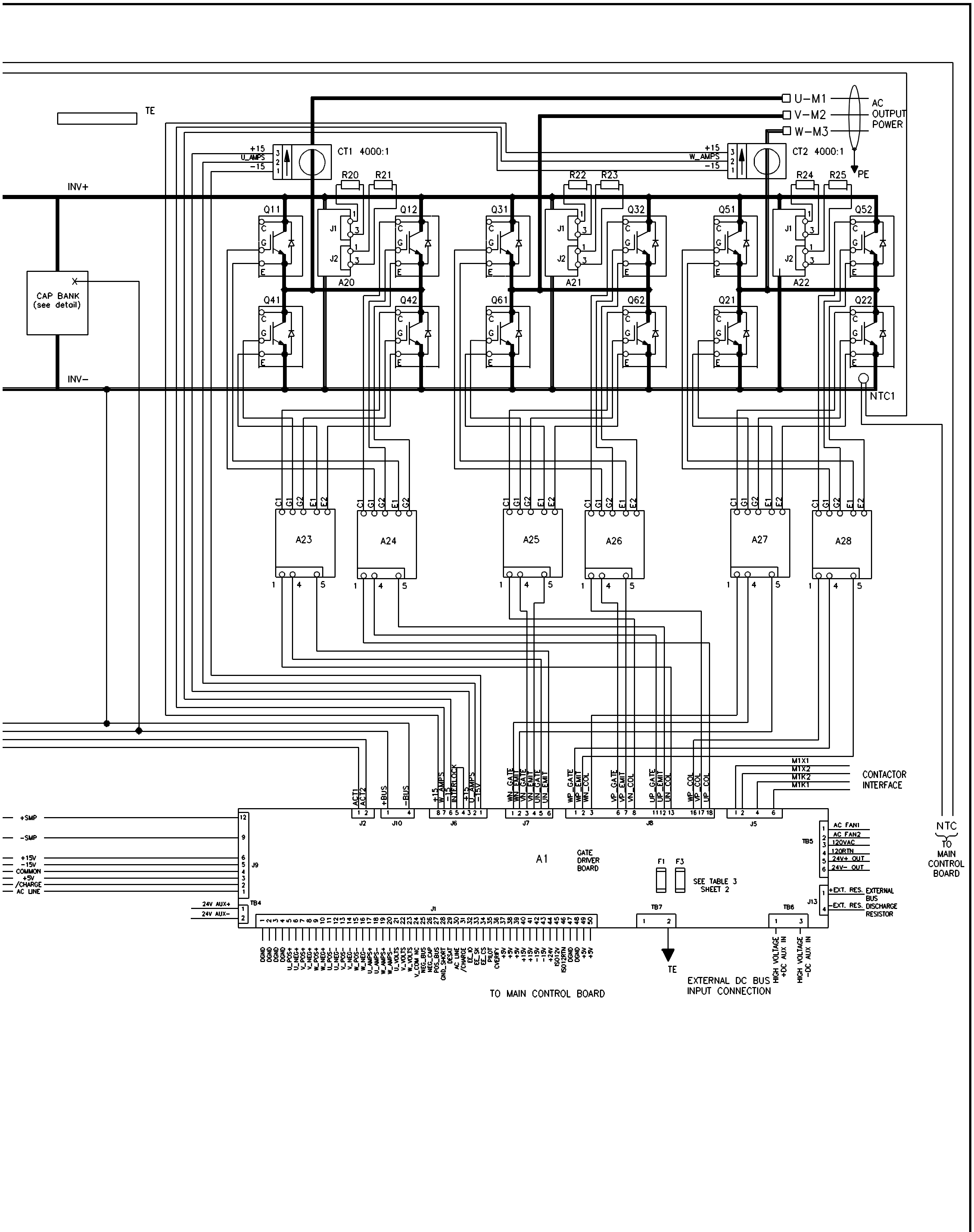
DRIVE HORSEPOWER, INPUT VOLTAGE	FUSE INFORMATION		
	RATING	TYPE	P/N
150/200/250 HP – 513/622/775 VDC	600A	A70Q600-4	25178-310-19
300 HP – 775 VDC	600A	A70Q600-4	25178-310-19

TABLE 3: BASED ON DRIVE HORSEPOWER, THE PRECHARGE FUSE, F2 FUSE WILL CHANGE AMP RATING. THE TABLE BELOW DEFINES THE FUSE RATING.

DRIVE HORSEPOWER, INPUT DC VOLTAGE	FUSE INFORMATION		
	RATING	TYPE	P/N
150/200/250HP – 513/622VDC	10A	FWP	25178-314-09
150/200/250/300HP – 775 VDC	15A	FWP	25178-314-11

300 - 600 HP @ 460 VAC / 650 VDC
300 - 650 HP @ 575 VAC / 820 VDC





300 - 600 HP @ 460 VAC / 650 VDC
300 - 650 HP @ 575 VAC / 820 VDC

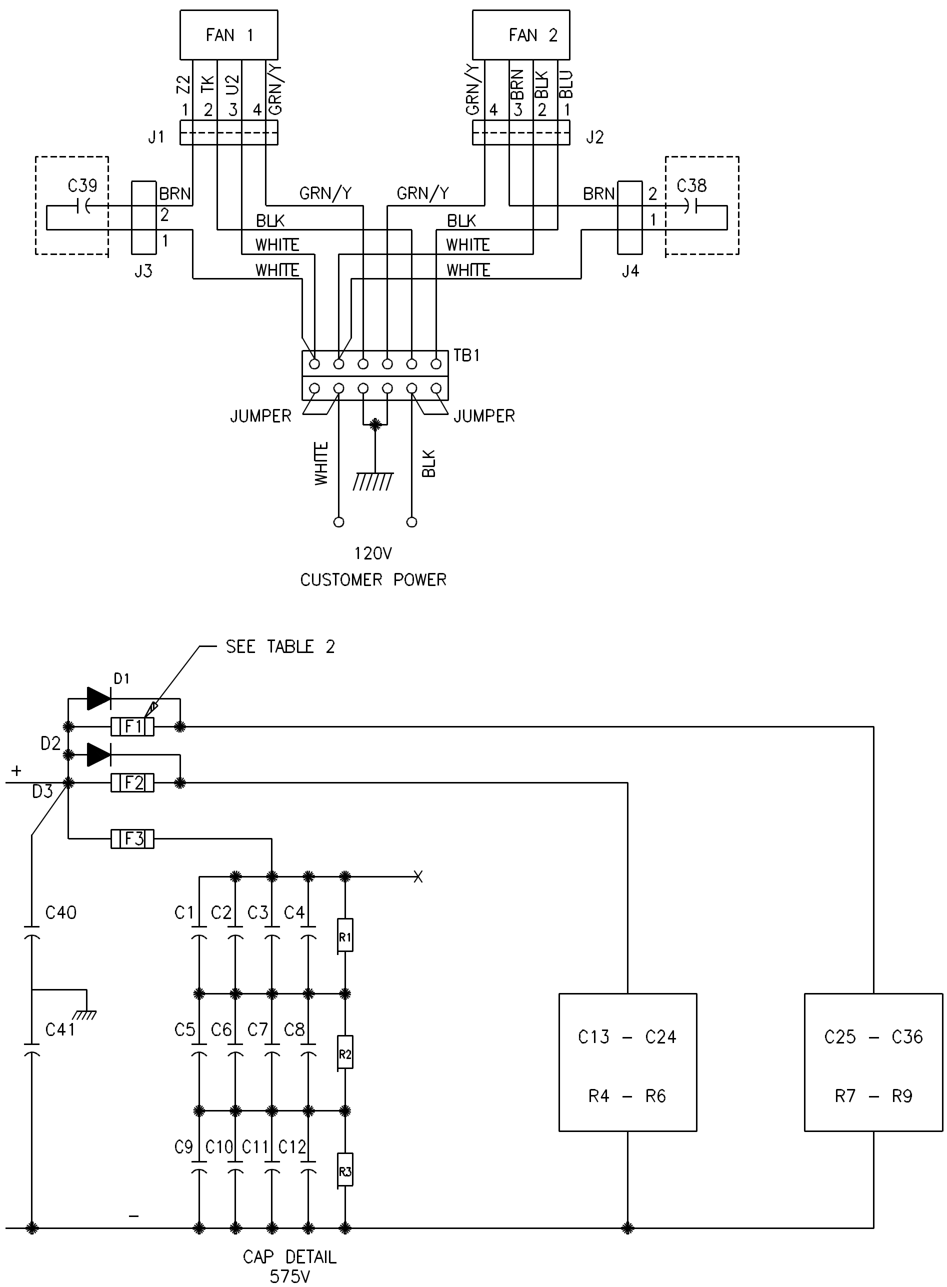


TABLE 1: CUSTOMER FUSING
BASED ON MAXIMUM DRIVE RATING THE FOLLOWING FUSES OR APPROVED EQUIVALENT MUST BE USED:

HORSEPOWER	513/622VDC FUSE CURRENT/TYPE	775VDC FUSE CURRENT/TYPE
300 HP	300 A TYPE SPP,FWP,A70Q	250 A TYPE SPP,FWP,A70Q
350 HP	350 A TYPE SPP,FWP,A70Q	300 A TYPE SPP,FWP,A70Q
400 HP	350 A TYPE SPP,FWP,A70Q	350 A TYPE SPP,FWP,A70Q
450 HP	450 A TYPE SPP,FWP,A70Q	400 A TYPE SPP,FWP,A70Q
500 HP	500 A TYPE SPP,FWP,A70Q	400 A TYPE SPP,FWP,A70Q
600 HP	500 A TYPE SPP,FWP,A70Q	500 A TYPE SPP,FWP,A70Q
650 HP	–	500 A TYPE SPP,FWP,A70Q

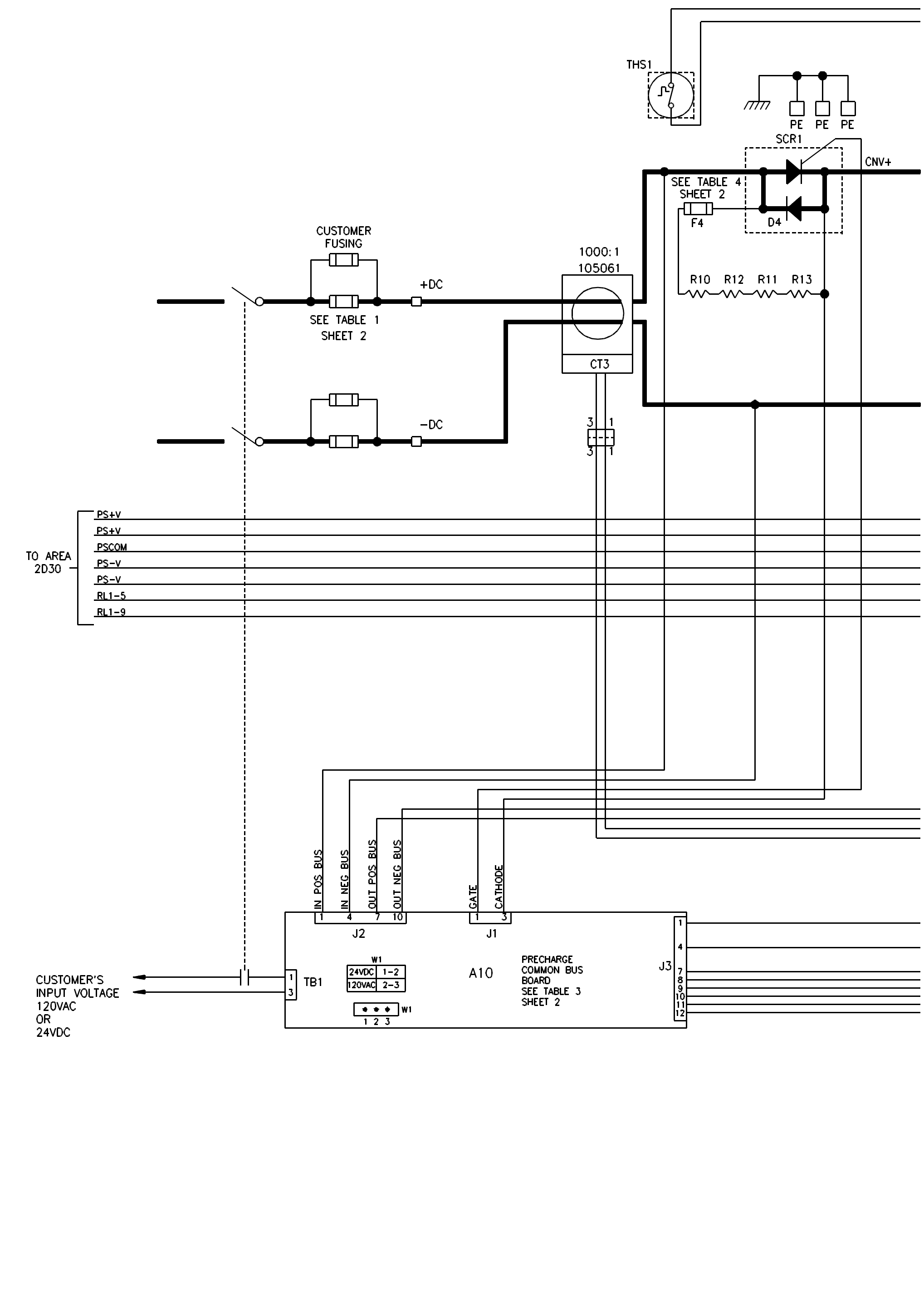
TABLE 2: BASED ON DRIVE HORSEPOWER, THE INVERTER DC + BUS FUSE WILL CHANGE AMP RATING. THE TABLE BELOW DEFINES THE FUSE RATING.

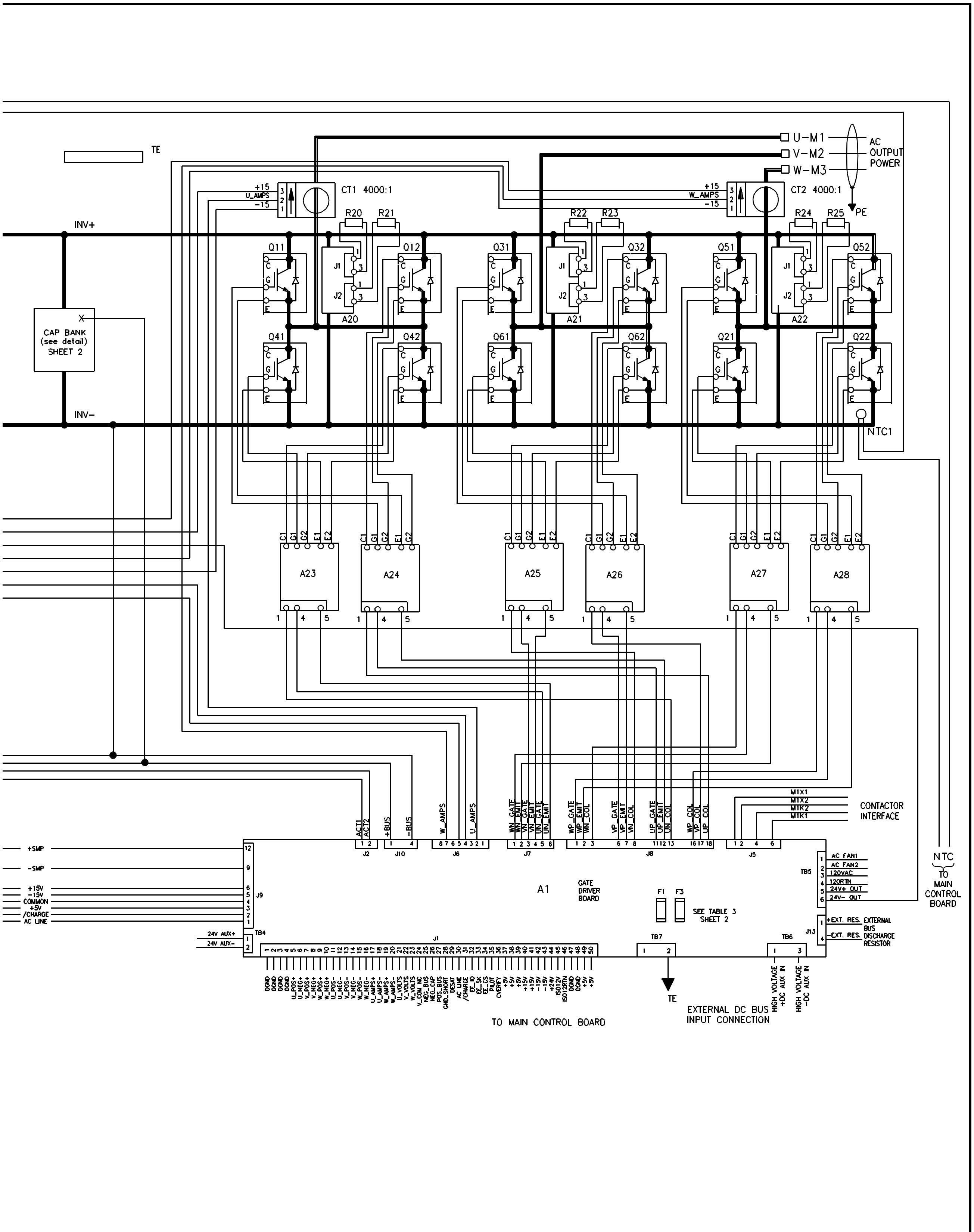
DRIVE HORSEPOWER, INPUT VOLTAGE	FUSE INFORMATION		
	RATING	TYPE	P/N
ALL SIZES	300A	A70Q	25178–310–14

TABLE 3: BASED ON DRIVE HORSEPOWER, THE PRECHARGE FUSE, F2 FUSE WILL CHANGE AMP RATING. THE TABLE BELOW DEFINES THE FUSE RATING.

DRIVE HORSEPOWER, INPUT DC VOLTAGE	FUSE INFORMATION		
	RATING	TYPE	P/N
622VDC	10A	A70P	25178–306–03
775VDC	15A	A70P	25178–306–04

800 HP @ 460 VAC / 650 VDC
800 HP @ 575 VAC / 820 VDC





U-M1
V-M2
W-M3
AC OUTPUT POWER
PE
CT1 4000:1
CT2 4000:1
INV+
INV-
CAP BANK (see detail) SHEET 2
NTC1
A23
A24
A25
A26
A27
A28
A1
GATE DRIVER BOARD
SEE TABLE 3 SHEET 2
CONTACTOR INTERFACE
NTC TO MAIN CONTROL BOARD
EXTERNAL BUS DISCHARGE RESISTOR
TO MAIN CONTROL BOARD
EXTERNAL DC BUS INPUT CONNECTION

800 HP @ 460 VAC / 650 VDC
800 HP @ 575 VAC / 820 VDC

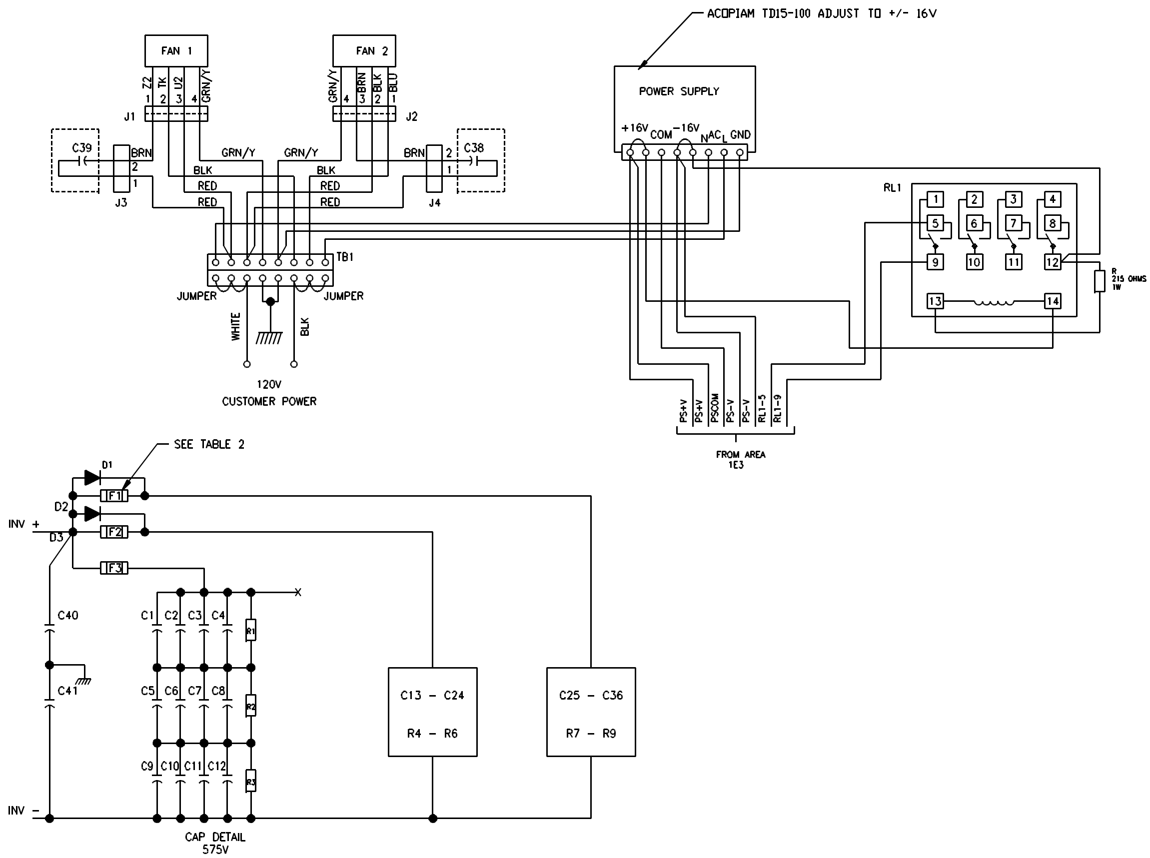


TABLE 1: CUSTOMER FUSING
BASED ON MAXIMUM DRIVE RATING THE FOLLOWING FUSES OR APPROVED EQUIVALENT MUST BE USED:

HORSEPOWER	513/622VDC FUSE CURRENT/TYPE	775VDC FUSE CURRENT/TYPE
800 HP	500 A TYPE SPP,FWP,A70Q	500 A TYPE SPP,FWP,A70Q

TABLE 2: BASED ON DRIVE HORSEPOWER, THE INVERTER DC + BUS FUSE WILL CHANGE AMP RATING. THE TABLE BELOW DEFINES THE FUSE RATING.

DRIVE HORSEPOWER, INPUT VOLTAGE	FUSE INFORMATION		
	RATING	TYPE	P/N
ALL SIZES	300A	A70Q	25178-310-14

TABLE 3: BASED ON DRIVE HORSEPOWER, THE PRECHARGE FUSE, F2 FUSE WILL CHANGE AMP RATING. THE TABLE BELOW DEFINES THE FUSE RATING.

DRIVE HORSEPOWER, INPUT DC VOLTAGE	FUSE INFORMATION		
	RATING	TYPE	P/N
622VDC	10A	A70P	25178-306-03
775VDC	15A	A70P	25178-306-04

Appendix D

Motor Cables

A variety of cable types are acceptable for SA3100 Power Module installations. For many installations, using separate conductors or unshielded cable is adequate. Signal wire for sensitive circuits must be run in separate conduit and be physically separated from inverter output cables. As an approximate guide, allow a minimum separation of 0.3 meters (1.0 ft) between cable types.

Motor cable should be 3-conductor with ground. The motor cables should run in the same wire raceway. The ground leads should be connected directly to the Power Module ground terminal (PE) and to the motor frame ground terminal.

Shielded Cable

Shielded cable, as referred to in this manual, is defined as any multi-conductor cable, with or without a ground conductor, that has a conductive metallic jacket surrounding the power conductors. The shield may be steel, aluminum, or copper, and may be continuous or spiral wrapped. The shield may provide physical protection for the cables, or may only provide a barrier to electrical fields, electrostatic or electromagnetic.

Shielded cable is recommended to help avoid interference with any sensitive circuits or devices that are present. The shield must be connected to the Power Module ground terminal (PE) and to the motor frame ground terminal.

If cable trays or large conduits are used to distribute the motor leads for multiple drives, shielded cable is recommended to reduce cross coupling of noise between the leads of different drives. The shield should be connected to the ground (PE) connections at both the motor and drive ends.

Armored cable may also provide effective shielding. Ideally, armored cable should be grounded only at the Power Module (PE) and motor frame. Some armored cable has a PVC coating over the armor to prevent incidental contact with grounded structure. If, due to the type of connector, the armor must be grounded at the cabinet entrance, shielded cable should be used within the cabinet to continue as far as possible to the coaxial arrangement of power cable and ground.

In some environments, such as the proximity of very high current electrical machines, it may not be not permissible to ground both ends of the cable shield. If the ground loop formed by the cable shield is cut by a strong magnetic field, a high circulating current may be produced. In this case, the ground connection at one end may be made through a capacitance. The capacitance will block the low frequency circulating current but present a low impedance to RFI. Because of the highly pulsed nature of the inverter output voltage, the capacitor type used must be rated for AC. Consult the factory for specific guidelines.

Conduit

> **ATTENTION:** To avoid possible shock hazard caused by induced voltages, unused wires in the conduit must be grounded at both ends. If a drive sharing a conduit is being serviced or installed, all drives using the same conduit should be disabled to eliminate shock hazard from cross coupled motor leads.

If metal conduit is used for cable distribution, observe the following guidelines:

- To minimize “cross talk” no more than three sets of motor leads should be routed through a single conduit. If more than three Power Module/motor connections per conduit are required, shielded cable must be used. Whenever practical, each conduit should contain only one set of motor leads.
- Power Modules are normally mounted in a cabinet with ground connections made at a common ground point within the cabinet. If the conduit is connected to the motor junction box and grounded at the Power Module end, no further conduit grounds are necessary.

Motor Lead Length

Installations with long motor cables may require the addition of output reactors or cable terminators to limit voltage reflections at the motor. Refer to table D.1 for the maximum length of cable allowed for various installation techniques.

Table D.1 – Maximum Recommended Motor Cable Lengths

Drive Rating	Termination Type	Maximum Cable Length in meters (feet) with 460V motor & Insulation of..			Maximum Cable Length in meters (feet) with 575V motor & Insulation of..		
		1000V	1200V	1600V	1000V	1200V	1600V
0.75 kW (1 HP)	None	12 (40)	33 (110)	121 (400)	Note 3	Note 3	Note 3
2.2 kW (3 HP)		7 (25)	12 (40)	121 (400)	Note 3	Note 3	Note 3
5.5 - 22 kW (7.5 - 30 HP)		7 (25)	15 (50)	121 (400)	Note 3	Note 3	15 (50)
30 - 45 kW (40 - X60 HP)		7 (25)	12 (40)	73 (240)	Not Recommended		12 (40)
45 - 112 kW (60 - X150 HP)		12 (40)	42 (140)	121 (400)	Not Recommended		15 (50)
112 - 187 kW (150 - 250 HP)		12 (40)	121 (400)	182 (600)		12 (40)	182 (600)
187- 448 kW (X250 - 600 HP)		Note 3	Note 3	Note 3	Note 3	Note 3	Note 3
5.5 - 22 kW (7.5 - 30 HP)	Reactor at Drive[1]	76 (250)	182 (600)	182 (600)	Not	Available	182 (600)
30 - 45 kW (40 - X60 HP)		91 (300)	182 (600)	182 (600)	91 (300)	121 (400)	182 (600)
45 - 112 kW (60 - X150 HP)		60 (200)	182 (600)	182 (600)	60 (200)	91 (300)	182 (600)
112 - 187 kW (150 - 250 HP)		182 (600)	182 (600)	182 (600)	182 (600)	182 (600)	182 (600)
187- 448 kW (X250 - 600 HP)		Note 3	Note 3	Note 3	Note 3	Note 3	Note 3
5.5 - 22kW (7.5 - 30HP)	Reactor at Motor[2]	182 (600)	182 (600)	182 (600)	182 (600)	182 (600)	182 (600)
30 - 45 kW (40 - X60 HP)		182 (600)	182 (600)	182 (600)	182 (600)	182 (600)	182 (600)
45 - 112 kW (60 - X150 HP)		152 (500)	182 (600)	182 (600)	152 (500)	182 (600)	182 (600)
112 - 187 kW (150 - 250 HP)		152 (500)	182 (600)	182 (600)	121 (400)	182 (600)	182 (600)
187- 448 kW (X250 - 600 HP)		Note 3	Note 3	Note 3	Note 3	Note 3	Note 3
5.5 - 448 kW (7.5 - 600 HP)	Terminator at Motor[3]	182 (600)	182 (600)	182 (600)	Not Recom.	182 (600)	182 (600)

1. A 3% reactor at the drive provides lower rise time and lower stress on the motor cable, but may produce a poorer waveform to the motor. The reactor must have a turn-to-turn insulation rating of 2100V or higher for 460V motors and 2600V or higher for 575V motors.
2. A 3% reactor at the motor has less effect on rise time and higher stress on the motor cable, but will provide a better waveform to the motor. The reactor must have a turn-to-turn insulation rating of 2100V or higher for 460V motors and 2600V or higher for 575V motors.
3. Product information not available at time of printing.

Optional Cable Terminator

Voltage doubling at motor terminals, known as reflected wave phenomenon, standing wave, or transmission line effect, can occur when using long motor cables with IGBT PWM Power Modules.

Inverter duty motors with phase-to-phase insulation ratings of 1600 volts or higher should be used to minimize effects of reflected wave voltages on motor insulation life.

Applications with non-inverter duty motors or any motor with exceptionally long leads may require an output inductor or cable terminator. An inductor or terminator will help limit voltage reflection at the motor to levels which are compatible with the motor insulation rating.

Table D.1 lists the maximum recommended cable length for unterminated cables since the voltage doubling phenomenon occurs at different lengths for different Power Module ratings. If your installation requires longer length motor cable lengths, a reactor or cable terminator is recommended.

Optional Reactors

The reactors listed in the SA3100 price list can be used for Power Module input and output. These reactors are specifically constructed to accommodate IGBT inverter applications with switching frequencies up to 20 KHz. They have a UL approved dielectric strength of 4000 volts, opposed to a normal rating of 2500 volts. The first two and last two turns of each coil are triple insulated to guard against insulation breakdown resulting from high voltage.

Common mode cores will help reduce the common mode noise at the Power Module output, and guard against tripping of the Power Module caused by capacitive leakage effects. The RMS capacitive currents are larger at higher PWM carrier frequencies. When using motor line reactors, it is recommended that the Power Module PWM frequency be set to its lowest value to minimize losses in the reactors.

Important: Using an output reactor will cause the effective motor voltage to be lower because of the voltage drop across the reactor. This may also result in a reduction of the motor torque.

Gate Driver Board Connections

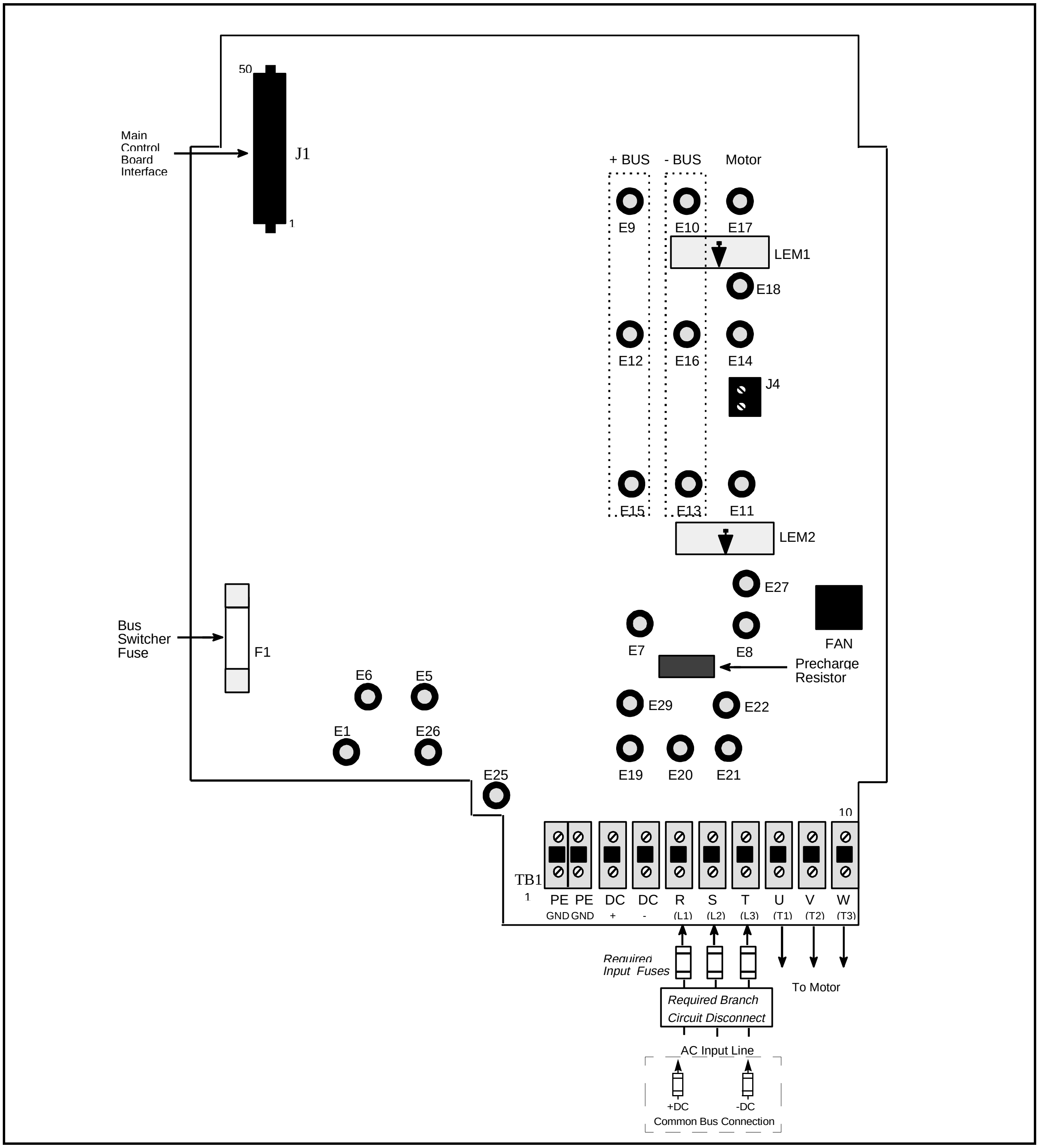


Figure E.1 – Frame Size B Gate Driver Board Connections

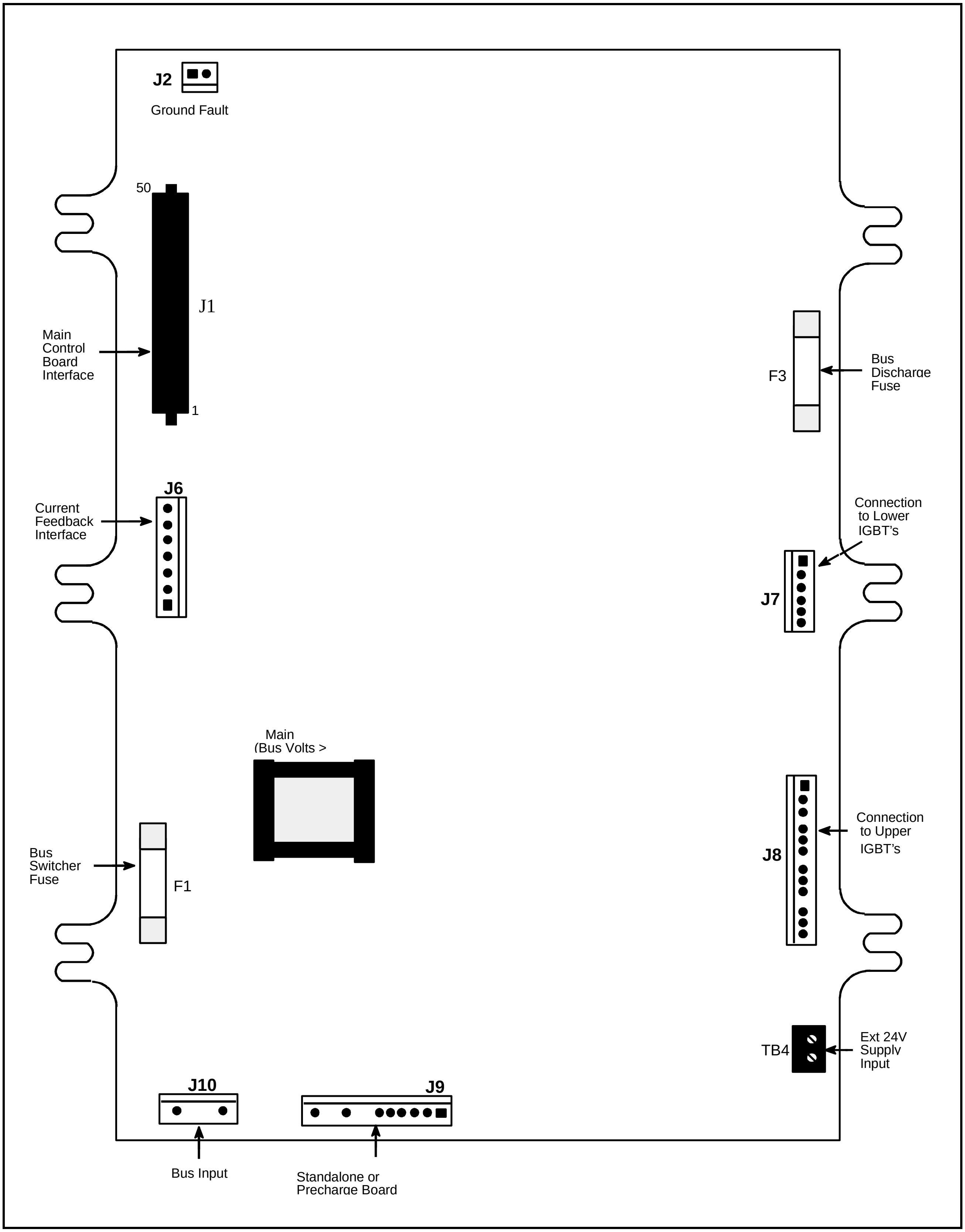


Figure E.2 – Frame Size C Gate Driver Board Connections

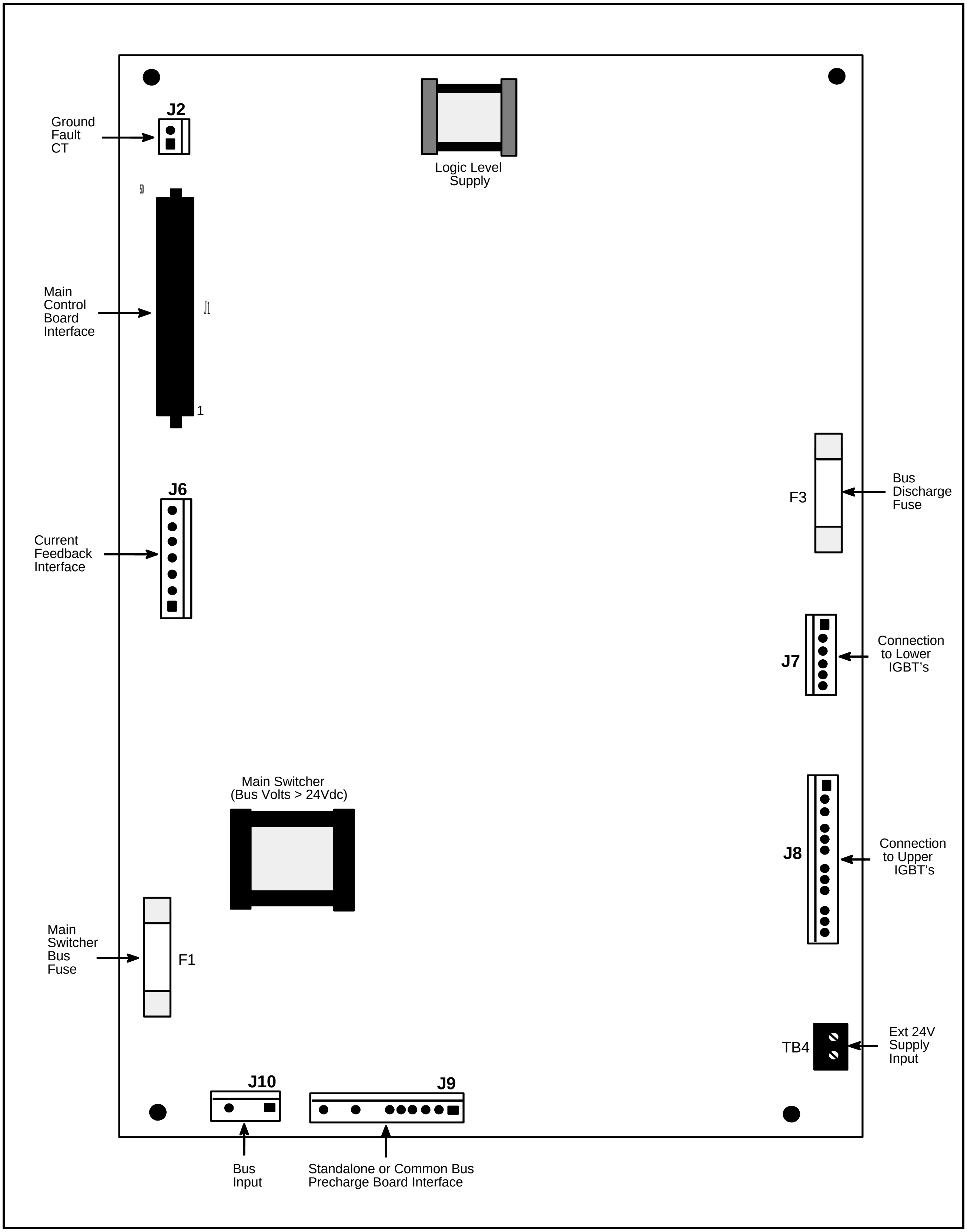


Figure E.3 – Frame Size D Through H Gate Driver Board Connections

APPENDIX F

SA3100 Internal DC Bus Control

Both AC and DC input SA3100 Power Modules contain a capacitor bank which must be charged before the Power Module can produce current. Because the capacitor bank acts like a DC bus, i.e., it supplies DC power to the inverter section of the Power Module, the capacitor bank is referred to as an “internal” DC bus.

An external DC bus, which can be used to supply DC voltage to DC input Power Modules, is provided by the user. This external DC bus is not under the control of the SA3100 drive.

The internal DC bus in each Power Module consists of the capacitor bank, pre-charge semiconductor, control circuitry, and resistors. See figures F.1 and F.2 for simplified internal DC bus schematics for both AC and DC input B frame Power Module configurations.

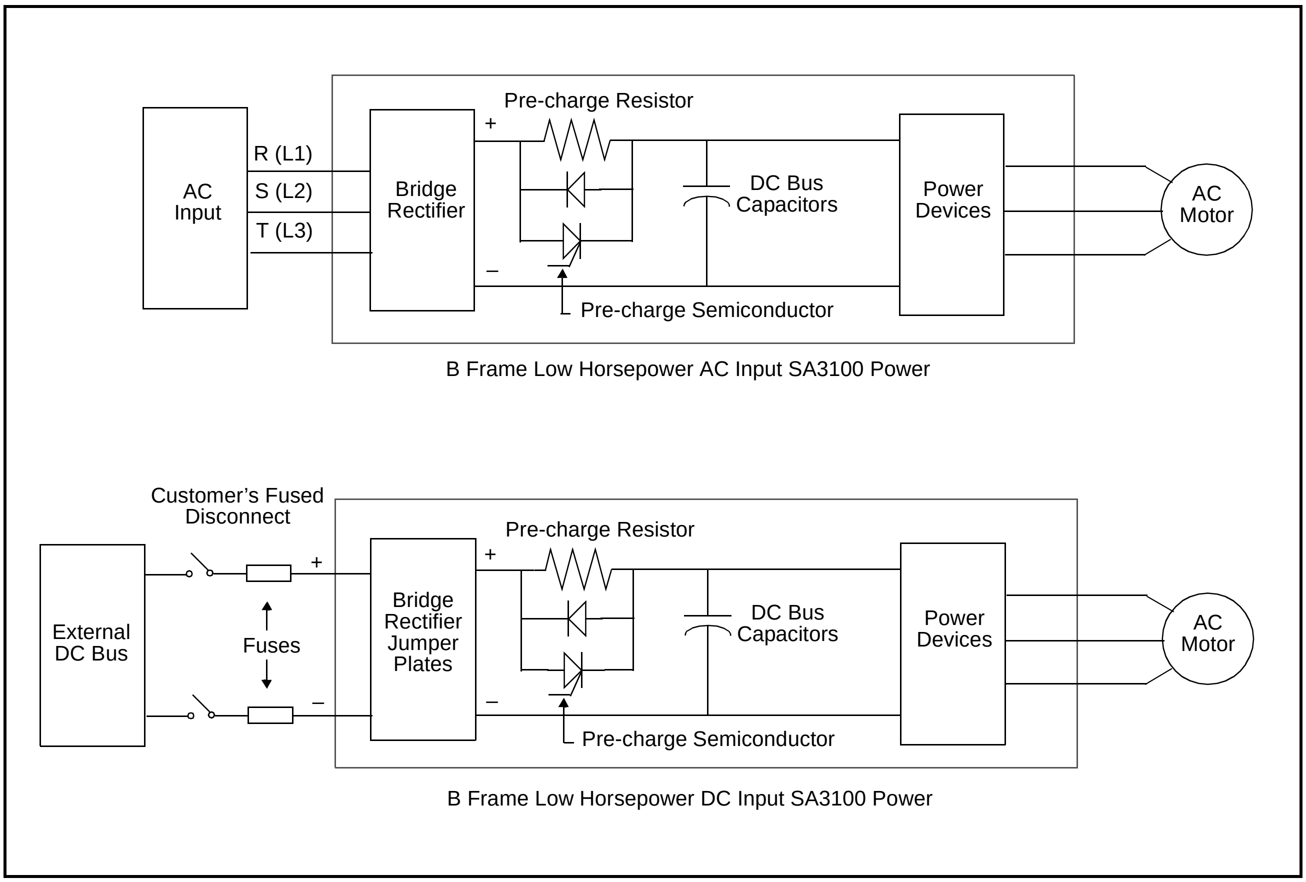


Figure F.1 – Internal DC Bus Schematics (B Frame Low Horsepower Power Modules)

Note that pre-charge circuit power on C frame or larger common bus units must be interlocked with the bus disconnect as shown in figure F.2 below. The connection is made to TB1 (pins 1 and 3) on the pre-charge printed circuit board. Either AC or DC voltage can be used. The selection is determined by the setting of jumper W1. 115 VAC is the default jumper setting.

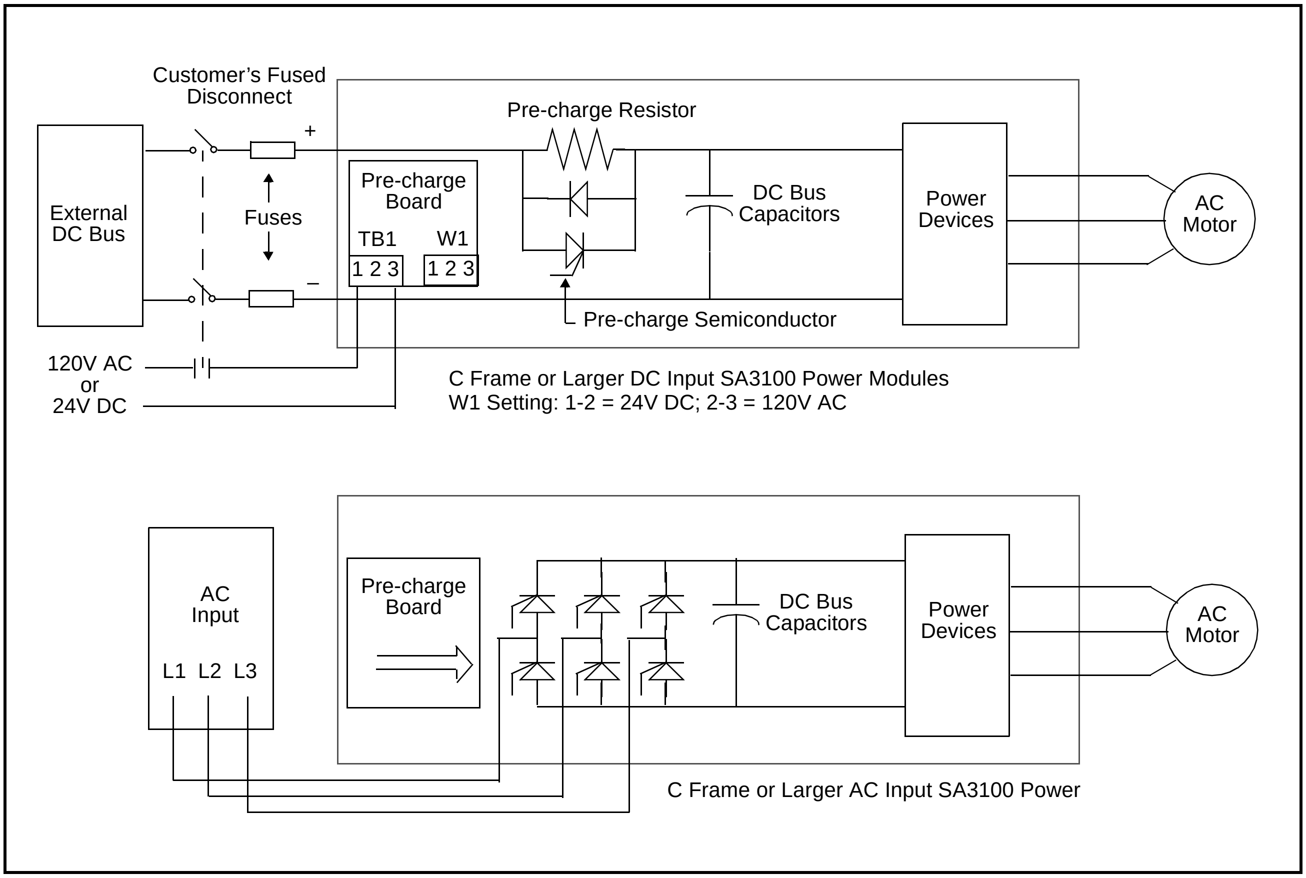


Figure F.2 – Internal DC Bus Schematics (C Frame or Larger Power Modules)

Input power (either via an external DC bus supply or 3-phase AC input, depending upon the Power Module) can be turned on either before or at the same time that bus control is enabled. On low horsepower (B frame) or common bus units (C frame and larger) the pre-charge semiconductor is initially off, allowing the bus capacitors to charge as soon as power is applied to the Power Module. This occurs regardless of whether or not bus control has been enabled by the programmer. In the absence of explicit control by the programmer, current to the bus is limited by the pre-charge resistors. On stand-alone (AC input) Power Modules, the bus is charged when bus control is enabled. This allows a phase advancing front end to charge the bus capacitors.

The programmer initiates control of the charging process by setting the BUS_ENA@ bit (register 100/100, bit 4). Normally, the PMI processor waits for the rising edge of this bit to start the process. However, if this bit is on at power-up, the PMI processor will interpret this as a positive transition.

Note that the bit must be turned on before the programmer enables the bridge test of the inner control loop in the PMI processor in register 100/1100. If BUS_ENA@ is not enabled first, an interlock error will occur (register 205.1205, bit 6, IC_BUS@) and the drive will not be permitted to execute either the bridge test or the control loop.

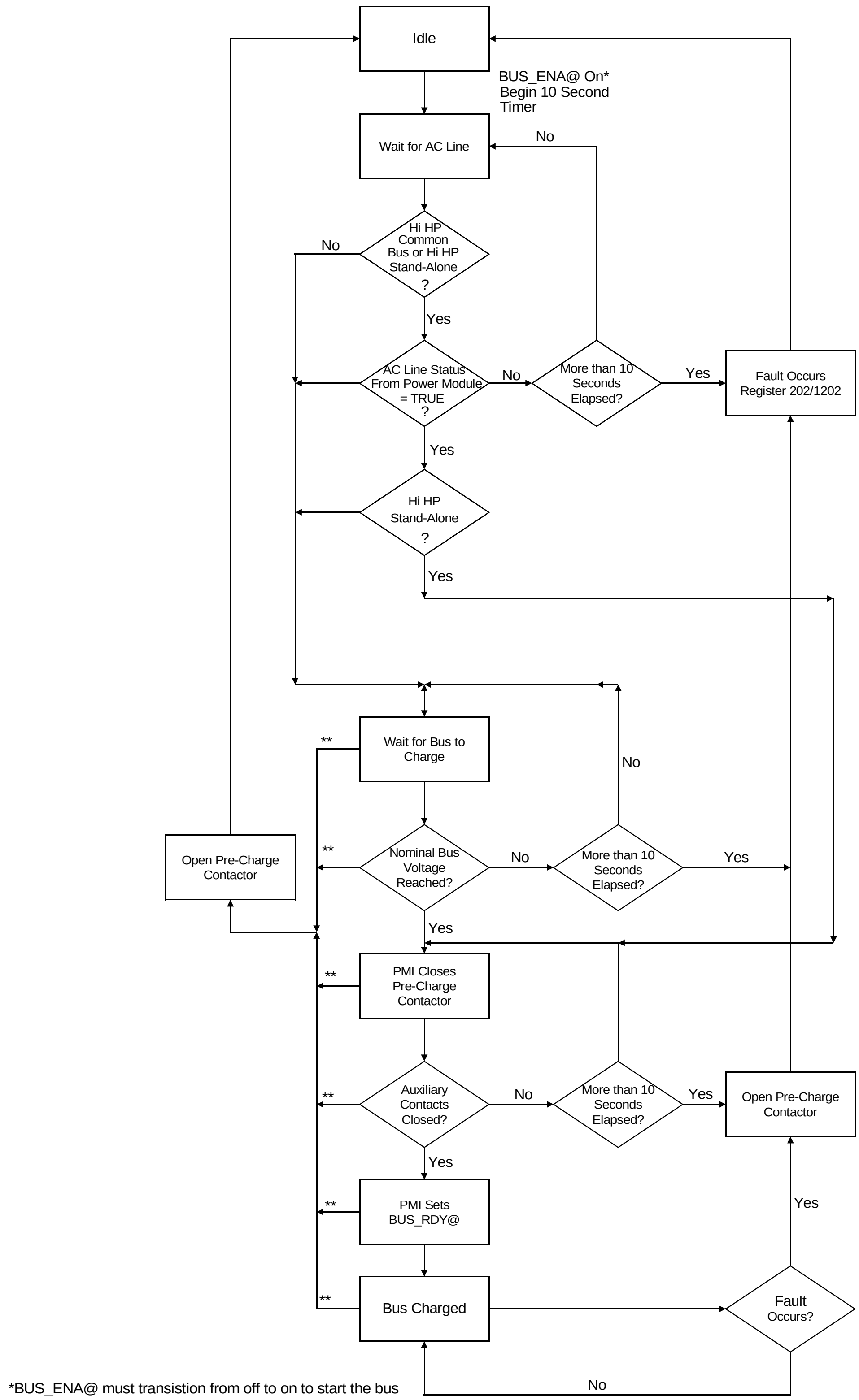
In response to the rising edge of the BUS_ENA@ bit, the PMI processor will allow the bus voltage to rise above the undervoltage threshold and then turn on the pre-charge semiconductor (Low voltage B frame Power Modules or common bus C frame or larger units). This will short out the pre-charge resistors. The PMI processor will set BUS_RDY@ (bit 4 in register 200/1200) when all of the following conditions have occurred:

- the internal DC bus has been enabled via the BUS_ENA@ input
- the internal DC bus voltage has reached the level specified in the tunable variable UVT_E0%
- the internal DC bus voltage is at steady state
- the pre-charge semiconductor is on

The BUS_ENA@ bit must remain on during the bridge test or the execution of the control algorithm in the PMI processor, or the pre-charge semiconductor will be turned off and the drive will shut down. If BUS_ENA@ is turned off at any time, power to the power device gates is shut off. Approximately one second later, the pre-charge semiconductor is turned off. If the pre-charge contactors close when they are not commanded to do so by the PMI processor, register 202/1202, bit 6 (FLT_CHG@) is set and the drive is shut down.

There is a time limit of 10 seconds from the time when the rising edge of the BUS_ENA@ input is detected to the time when the bus voltage must reach the steady state voltage specified in the tunable variable UVT_E0% (See the following section for more information on tunable variable UVT_E0%). If this time limit is exceeded, the pre-charge semiconductor is turned off and the FLT_CHG@ bit (register 202/1202, bit 6) is set. If the bus voltage recovers to the appropriate level within 10 seconds, the pre-charge semiconductor will be turned on and the drive will resume operation.

Refer to the internal DC bus flowchart (figure F.3) for more detailed information.



*BUS_ENA@ must transistion from off to on to start the bus charging process.

**BUS_ENA@ must remain on during the drive operation

Figure F.3 – Internal DC Bus Control Flowchart

F.1 Modifying Internal DC Bus Voltage Thresholds

The programmer can use three different pre-defined tunable variables to specify three bus voltage thresholds:

- OVT_E0% overvoltage threshold
- UVT_E0% undervoltage threshold
- PLT_E0% power loss threshold

These thresholds define the boundaries for specific operating levels. Figure F.4 shows the relative bus voltage operating ranges and how the tunable variables can affect these ranges.

Important: The three tunable variables listed above should be tuned before enabling the execution of the control algorithm in the PMI processor in order to ensure that internal DC bus voltage warning thresholds are set to levels appropriate for the application. See instruction manual S-3056, SA3100 Drive Configuration and Programming, for the acceptable value ranges.

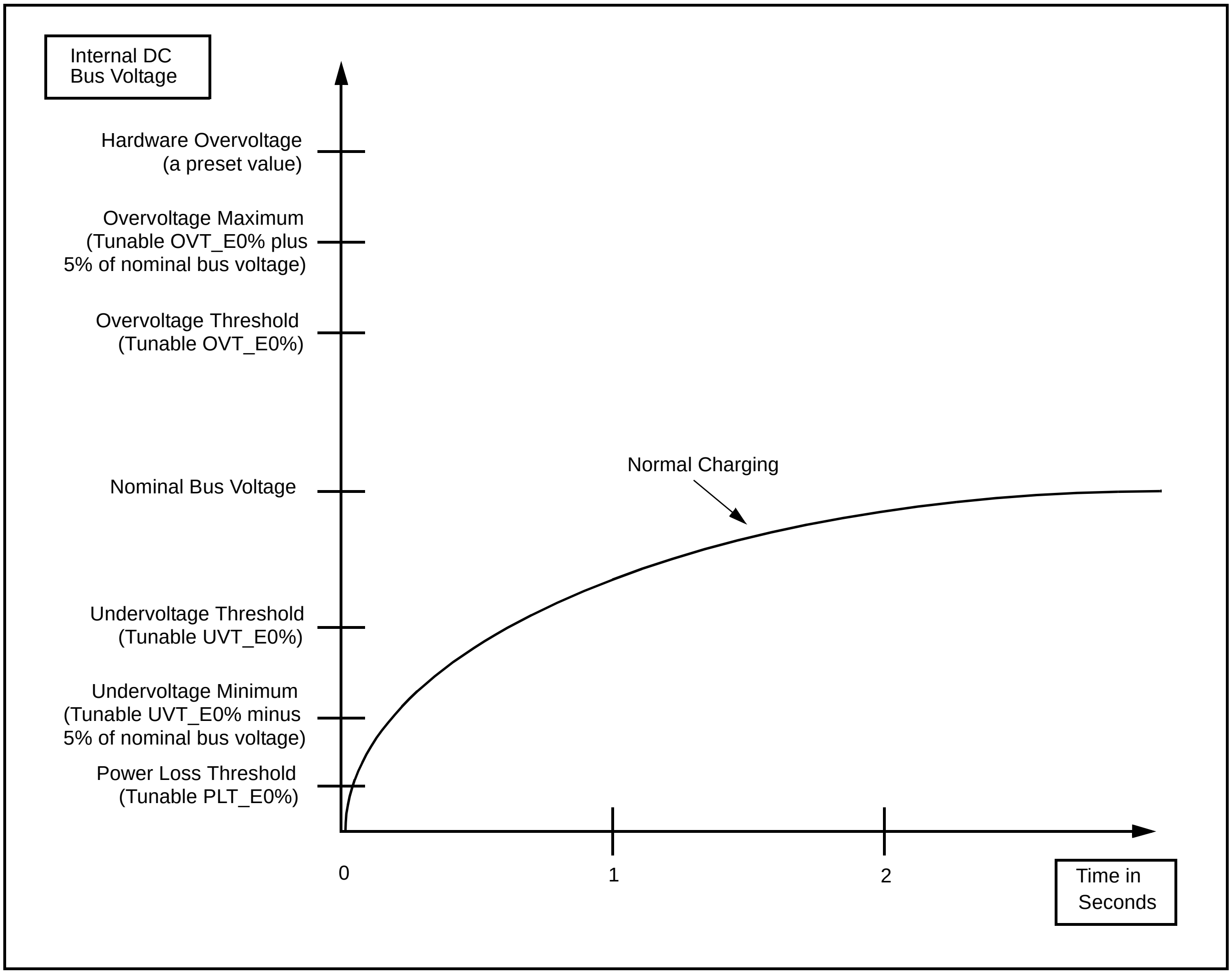


Figure F.4 – Internal DC Bus Operating Range

F.2 Internal DC Bus Protection

The PMI processor will modify the regeneration or motoring torque limit set by the programmer during parameter entry (calculated from the maximum current and overload ratio parameters) to prevent bus voltage from rising (in the case of regeneration) or falling (in the case of motoring).

During regeneration, if bus voltage reaches the overvoltage threshold, the regeneration torque limit will be reduced, and will be set to zero if the overvoltage maximum is reached. During motoring, if bus voltage reaches the undervoltage threshold, the motoring torque limit will reduced, and will be set to zero if the undervoltage minimum is reached. The PMI processor will set register 203/1203, bit 4 (WRN_RIL@), to indicate that torque is being limited in either direction.

Note that the PMI processor does not modify the reference provided by the UDC task to the PMI processor via register 102/1202, TRQ_REF%. If required, the UDC task can include logic to begin regenerating when DC bus voltage is low.

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